The Engineer

LONDON, FRIDAY, AUGUST 7, 1942.

PUBLIC NOTICES

COUNTY BOROUGH OF READING

WATER DEPARTMENT

PANGBOURNE PUMPING STATION

PUMPING MACHINERY

The Corporation of Reading invite TENDERS from Manufacturers of Waterworks Pumping Machinery for the SUPPLY and ERECTION complete of a HEAVY OIL ENGINE-DRIVEN CENTRIFUGAL BORE-HOLE PUMPING PLANT, having a capacity of two million gallons per day, together with Auxiliary Plant and Accessories.

Copies of the specification and other relevant particulars may be obtained on application at the office of the Water Engineer and Manager, Town Hall, Reading, upon payment of a deposit of three Guineas (cheques to be made payable to the Borough Accountant, Reading), which will be refunded upon the receipt of a bona-fide tender and the return of all the documents.

Tenders must be delivered to the undersigned not later than Twelve Noon, Saturday, 29th August, 1942. No Tender will be considered unless enclosed in the plain envelope provided, sealed and endorsed "Tender for Pangbourne Pumping Plant," but not bearing any name or mark indicating the sender.

The Corporation do not bind themselves to accept the lowest or any Tender.

C. S. JOHNSON,
Town Clerk.

Town Hall,
Reading,
29th July, 1942. 8663

UNIVERSITY OF ST. ANDREWS

DEPARTMENT OF ENGINEERING
(FACULTY OF SCIENCE)

UNIVERSITY COLLEGE, DUNDEE

The University Awards the DEGREE of B.Sc. in Engineering. The courses are designed for students desiring to qualify as MECHANICAL, CIVIL, or ELECTRICAL ENGINEERS. They also cover the subjects of examination for Associate Membership of the Institutions of Civil, Mechanical, and Electrical Engineers.

The Department is housed in commodious and well-equipped buildings, and provides ample facilities for research. Prospectus, giving full particulars of Courses and of Entrance and Post-graduate Scholarships, may be had on application to—

THE SECRETARY, THE UNIVERSITY, ST. ANDREWS; or
THE SECRETARY, UNIVERSITY COLLEGE, DUNDEE.

SESSION COMMENCES OCTOBER, 1942.
8671

UNIVERSITY OF MANCHESTER

FACULTY OF SCIENCE.
DEPARTMENTS OF CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERING.

Complete Courses of Study, extending over three years, lead to the University Degree in Civil, Mechanical, and Electrical Engineering. A prospectus giving full information may be obtained on application to the REGISTRAR.

The SESSION COMMENCES on THURSDAY, OCTOBER 1st.

DEPARTMENTS.

Professor A. H. GIBSON, D.Sc., LL.D., M. Inst. C.E., M.I. Mech. E. (Engineering).
Professor WILLIS JACKSON, D.Sc., D.Phil., A.M.I.E.E., F. Inst. P. (Electrical Engineering).
Professor L. J. MORDELL, B.A., M.Sc., F.R.S. (Pure Mathematics).
Professor A. R. TODD, D.Sc., Dr. Phil. nat., D.Phil. (Organic Chemistry).
Professor MICHAEL POLANYI, M.Sc., M.D., Ph.D. (Physical Chemistry).
Professor P. M. S. BLACKETT, M.A., F.R.S. (Physics).
Professor D. R. HARTREE, M.A., M.Sc., Ph.D., F.R.S. (Theoretical Physics).
Professor F. C. THOMPSON, M.Sc., D.Met. (Metallurgy).
Professor W. J. PUGH, O.B.E., D.Sc., B.A. (Geology). 8673

UNIVERSITY OF MANCHESTER

PHYSICS DEPARTMENT

Full Particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR. The SESSION COMMENCES on Thursday, OCTOBER 1st. 8672

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE

ARRANGED FOR CARD INDEXING

(TABLE OF CONTENTS, PAGE 114)

Model Quality Control Charts—No. III (P. 106)
(H. RISSIK) THE ENGINEER, 7 - 8 - 42

Excavating Machinery in the Ironstone Fields—No. I (P. 108)
(W. BARNES) THE ENGINEER, 7 - 8 - 42

Supervisory Remote Control for Wellington, New Zealand (P. 116)
(E. M. S. McWHIRTER & H. J. WARD) THE ENGINEER, 7 - 8 - 42

British Association—No. II (P. 111)
THE ENGINEER, 7 - 8 - 42

Royal Ordnance Factories—No. II (P. 121)
THE ENGINEER, 7 - 8 - 42

American Copper Mine and Reduction Works—No. III (P. 120)
THE ENGINEER, 7 - 8 - 42

The Safety Factor of Winding Ropes in Deep Shafts (P. 119)
(D. R. BEAN) THE ENGINEER, 7 - 8 - 42

HYDROJET ASH & DUST SLUICING
BABCOCK & WILCOX LTD.

INDEX TO ADVERTISEMENTS, PAGE 55

NOTICE

CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:

28, ESSEX STREET, STRAND, LONDON, W.C.2, and NOT to Bath.

This change has been caused by enemy action, and co-operation is earnestly asked for.

PUBLIC NOTICES

WOOLWICH POLYTECHNIC

LONDON, S.E.18

The Governing Body Invite APPLICATIONS for the POST of LECTURER in CIVIL and MECHANICAL ENGINEERING duties to commence on the 1st September. Salary up to £528 per annum, according to Teaching, Research, and Industrial Experience, Burnham London scale. Candidates should have industrial, design and laboratory experience, and preference will be given to those who can qualify to become recognised Teachers of the University of London.

Particulars of the appointment and forms of application may be obtained from the SECRETARY on receipt of a stamped addressed envelope. 8680

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, an Experienced SUPERINTENDENT MAINTENANCE ENGINEER for Hydraulically Operated Shell Forging Plant. State age, experience, and when free to commence duties.—Address, 8665, The Engineer Office. 8665 A

LANCASHIRE FIRM of SAW-MILLERS REQUIRE SERVICES of capable HEAD FOREMAN with first-class practical experience of Woodworking Machinery, to Take Charge of Plant, including Boilers, Compressed Air Plant, Woodworking Machines and Tools, Electrical Plant, and Motor Vehicles. Good prospects for continuance of work after war. Applicants should stage age, previous experience, and educational standard. Salary £300–£350 per annum, plus overtime and bonus.—Address, P4283, The Engineer Office. P4283 A

PUBLIC NOTICES

HERIOT-WATT COLLEGE, EDINBURGH

(AFFILIATED WITH THE UNIVERSITY OF EDINBURGH)

Full-Time Three Years' DIPLOMA COURSES in MECHANICAL ENGINEERING and ELECTRICAL ENGINEERING.

Mechanical Engineering: Professor A. R. HORNE, O.B.E., B.Sc., M.I. Mech. E., A.M.I.C.E.

Electrical Engineering: Professor M. G. SAY, Ph.D., M.Sc., A.M.I.E.E.

Entrance Examination for those not otherwise qualified for admission, 22nd and 23rd September. Three Scholarships, value £35 per annum, are offered on the results of this Examination.

SESSION BEGINS MONDAY, 5th OCTOBER. Prospectus sent free on application.

J. CAMERON SMAIL,
Principal.

8590

DORSET COUNTY COUNCIL EDUCATION COMMITTEE

SOUTH DORSET TECHNICAL COLLEGE, WEYMOUTH

The Governors Invite Applications for the PERMANENT APPOINTMENT of PRINCIPAL, to take up duty as early as possible.

The work of the College includes Evening Courses in Technical, Commercial and General Subjects, as well as Full-time Day Courses.

Candidates must be able administrators and organisers, and must not be more than 45 years of age. A Degree (Honours desirable) or equivalent qualification in either Engineering, Commerce, or Science, and teaching experience (preferably as Head of a Department in a Technical College), and industrial or commercial experience, are essential requirements.

Salary £650 per annum, rising, subject to satisfactory service, by annual increments of £25 to £825 per annum.

Canvassing, directly or indirectly, will disqualify.

Application forms (with further particulars) may be obtained from me, and must be returned to me by 31st August, 1942.

A. F. ALEXANDER,
Acting County Education Officer.

Education Department,
Shire Hall,
Colliton Park,
Dorchester,
Dorset. 8677

SITUATIONS OPEN

AN EFFICIENT ORGANISER is REQUIRED for the Development and Research Department of large firm manufacturing Industrial Electrical Equipment. Applicants should have practical experience of Gas, Arc, and Resistance Welding Practice, and should be able to Plan a Development Programme.—Write, stating age, previous experience, and salary required, to 8678, The Engineer Office. 8678 A

LONDON FIRM of GENERAL ENGINEERS and IRONFOUNDERS REQUIRES MANAGER for Factory in Midlands employing 300 hands.—Address, giving summary of previous experience, positions held and salary required, P4269, The Engineer Office. P4269 A

For continuation of Small Advertisements see page 2.

SITUATIONS OPEN (continued) Page 2
SITUATIONS WANTED, Page 2
AUCTIONEERS & VALUERS, Page 56
AGENCIES, Page 56
PATENTS, Page 56
FOR SALE, Page 56
MACHINERY, &c., WANTED, Page 2
EDUCATIONAL, Page 2
SUB-CONTRACTING, Page 2

For Advertisement Rates see First Column Overleaf

CLASSIFIED ADVERTISEMENTS CLOSE FOR
PRESS-NOON WEDNESDAYS

The Engineer

Annual Subscription Rates

(including postal charges)

BRITISH ISLES	£3	5	0
CANADA	£2	18	6
ABROAD...	£3	3	0

(except Canada)

ADVERTISEMENTS

The Charges for Classified Advertisements are 1/6 per line up to one inch—minimum charge, 6/-; those occupying one inch or more at the rate of 18/- per inch. Box numbers, 1/- extra, except in the case of advertisements under "Situations Wanted." Orders MUST be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
28, Essex Street, Strand, London, W.C.2.

Teleg. Address,
"Engineer Newspaper, Estrand, London."
Tel., Central 6565 (10 lines).

SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS
1941 No. 2069

RESTRICTION ON ENGAGEMENT ORDER

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

NIGHT SHIFT SUPERINTENDENT for Small Factory in S.E. County; good disciplinarian, but balanced personality. Small Components in large quantities off Autos. and Capstans. Reply, stating age, qualifications, when free, and salary required.—Address, 8683, The Engineer Office. 8683 A

OWING to the Impending Retirement of Mr. D. A. Bremner, GENTLEMEN with outstanding ability are INVITED to APPLY for the POSITION of DIRECTOR of the BRITISH ENGINEERS' ASSOCIATION. Good personality essential, also energetic but co-operative disposition; knowledge of the organisation of engineering and allied industries desirable.—Full particulars, stating qualifications and career, to be addressed under confidential cover to the PRESIDENT, British Engineers' Association, 32, Victoria Street, London, S.W.1. 8679 A

SMALL ENGINEERING WORKS OFFERS INTERESTING PROPOSITION to a practical ENGINEER, able to take over management. Nominal financial investment available, if required, but is not essential.—Full particulars, please, Box 950, Smiths, Square, Bournemouth. P4287 A

TECHNICAL ASSISTANT or ENGINEER FOREMAN for Pre-Cast Concrete Work in South Wales.—Address, 8684, The Engineer Office. 8684 A

THE NORTH NORFOLK RIVERS CATCHMENT BOARD REQUIRES the SERVICES of a young qualified CIVIL ENGINEER, with experience in Land Drainage and Coastal Defence Works, as Engineer to the Board.—Apply, stating salary required and sending three recent testimonials, to the CLERK TO THE BOARD, Swan Street, Fakenham, Norfolk. 8682 A

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

WATERWORKS ENGINEERING ASSISTANT, with knowledge of Waterworks Construction, Pipe-laying, Distribution, and Chlorination. Experience in a Water Engineer's Office essential. £400 p.a.—Particulars of age, qualifications, experience, and testimonials, to ENGINEER and MANAGER, West Surrey Water Company, Walton Bridge Works, Walton-on-Thames. 8681 A

SITUATIONS WANTED

DESIGNER, with Small Technical Staff, WISHES to UNDERTAKE SPARE-TIME WORK. Jigs, tools, development of inventions, machinery, &c.—Address, P4289, The Engineer Office. P4289 B

ENGINEER DESIGNER REQUIRES EXECUTIVE POSITION; machine tools, special-purpose m/cs, jigs and tools, planning, &c.; London area.—Address, P4290, The Engineer Office. P4290 B

SITUATIONS WANTED

ENGINEER, University Degree, Austrian Refugee; 20 years' general engineering experience on the Continent in mass production, planning, machine tools, etc., high organising abilities, SEEKS POSITION (also as Draughtsman).—Address, P4292, The Engineer Office. P4292 B

GENERAL FOUNDRY MANAGER and METALLURGIST (37), controlling ferrous and non-ferrous foundries, heat treatment dept. and laboratories, with first-class experience in producing castings of many types in wide range of material, DESIRES CHANGE. Minimum salary considered, £1000 p.a.—Address, P4288, The Engineer Office. P4288 B

IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers, 1s. extra, which includes despatch of all replies.

MODERN ENGINEER (42), with 26 Years' practical experience of wide and varied nature in elect. and mechanical engineering and building maintenance, DESIRES CHANGE for a position in S.W. of England. Last 12 years as administrative factory engineer. Present salary £800 p.a.—Address, P4280, The Engineer Office. P4280 B

STORES/MATERIAL CONTROL MANAGER (48) DESIRES POSITION; 18 years' first-class experience of modern organisation, English and American; previously D.O., m/c shop and costing experience; A.I.D., W.O., and sub-contracts; London or provincial; inquiries confidential.—"MANAGER," 16, Ivor Road, Birmingham, 11. P4293 B

WORKS MANAGER, Reorganisation, Systems, methods expert. London or near. Immediate results.—Address, P4267, The Engineer Office. P4267 B

MACHINERY, &c., WANTED

WANTED, DOUBLE-ENDED PUNCHING and SHEARING MACHINE, with Angle Cropper, approx. 7/8in. capacity.—Address, 8675, The Engineer Office. 8675 F

WANTED, ONE 100-Ton SINGLE-ACTION PRESS, 6in. stroke, 3ft. 6in. between uprights with cushion, Bland, and draws to 3in. depth. ONE 100-Ton DOUBLE-ACTION PRESS, 3ft. 6in. between uprights (deep draw). Full particulars.—Address, 8676, The Engineer Office. 8676 F

WANTED, CYLINDERS and VALVES for Water Softeners, 300, 400, 500 capacity.—State price to WHEELER and SONS, The Softener Men, 1, High Street, Scunthorpe. P4266 F

ALL CLASSES OF MACHINE TOOLS WANTED. Cash paid.—NORMAN POTTS, 105, Alcester Road South, Birmingham, 14. 8649 F

We are licensed by the Machine Tool Control for the purchase of all classes of Machine Tools, and we offer good prices for surplus Machinery in any quantities, large or small.

F. J. EDWARDS, LTD.
359, EUSTON ROAD, LONDON, N.W.1
Telephone No.: EUSton 4681
Telegrams: "Bescotools, Norwest, London."

ALFRED HERBERT, Ltd., Coventry, PAY BEST PRICES for SECOND-HAND MACHINE TOOLS in good condition by first-class makers.
Write, wire, or 'phone, and our representative will call.
'Phone: 88781 (12 lines), Coventry. Telegrams: "Lathe, Coventry." 1002 F

PORTABLE CONVEYOR WANTED, Suitable for coal stacking, approximate size 30ft. by 14in., motive power A.C. electric motor or petrol engine. Send full details.—Address, P4286, The Engineer Office. P4286 F

Vertical Milling Machines
all geared, hardened and ground throughout, ball and roller bearings, swivelling head, 30"x8" Table
HENRY MILNES LIMITED, Machine Tool Works
Ingleby Street, BRADFORD

SUB-CONTRACTING

WANTED

MACHINING WORK REQUIRED, Large or small lots, suitable for Centre Lathes (9in. crs. by 8ft.), Slotters, Drills, Shapers, Planers, &c.—STRINGERS, Ltd., Wincobank, Sheffield. 8084 MW

POWER and HAND FORGING WORK WANTED up to 3in. square.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8660 MW

PRECISION TUBE and BAR BENDING WORK WANTED.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8661 MW

PROFILING WORK WANTED.
COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8659 MW

SPOT WELDING WORK WANTED.
Capacity 40 kVA welding 2, ¼in. thicknesses.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8658 MW

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WORK WANTED in all Metals. 20-ton presses.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8662 MW

OFFERED

REQUIRED, ENGINEERING FIRM to UNDERTAKE the MANUFACTURE of SMALL MACHINES against samples and drawings; patterns and castings could be supplied. Continuous runs of priority work. Please send details of plant available for this work.—Address, P4282, The Engineer Office. P4282 MO

EDUCATIONAL

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25 FIRST PLACES

and HUNDREDS OF PASSES in the A.M. Inst. C.E., A.M.I. Mech. E., A.M.I. E.E., A.F.R.Ae.S., A.M.I. Chem. E., C. & G., etc. Examinations have been gained by T.I.G.B. Students.

Especially in view of Air Raid and Working Conditions, study at home with the T.I.G.B. in order to achieve the best progress and results. Write to-day for "The Engineer's Guide to Success"—FREE—containing the world's choice of Engineering Courses—over 200—covering all branches and recognised qualifications. Mention branch, post of qualifications that interests you. The T.I.G.B. guarantees training until successful

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
76, TEMPLE BAR HOUSE, LONDON, E.C.4.

For continuation of Small Advertisements see page 56.

BRITISH "REMA"
Manufacturing Co. Ltd., SHEFFIELD
(Proprietors: EDGAR ALLEN & CO., LTD.)
Coal Firing Plant.

Rapidor **MACHINE TOOLS**
EDWARD G. HERBERT LTD.
ATLAS WORKS, LEVENSHULME, MANCHESTER 19
See Illustrated Advt. July 3rd.

YOU have been waiting for - - - **THE PERFECT**
DIBYCOIL **RUST-SOLVENT**
REGD. TRADE MARK
Indispensable for Engineers
Full details from
DIBYCO LIMITED
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101, St. Vincent Street, Glasgow, C.2
DIBYCOIL
loosens everything rustbound
prevents friction and helps to lower repair costs, as it saves time, temper and money. It is economical in use and should ALWAYS BE AT HAND WHERE RUST PROBLEMS MAY OCCUR. AGENTS REQUIRED IN ALL DISTRICTS

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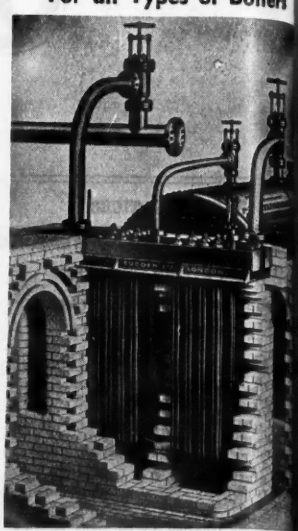
For all Types of Boilers



Downtake Superheater as applied to Lanc... Boilers

10% TO 20% SAVING IN FUE...
Also IMPROVED WORKING of STEAM ENGINES and TURBI...
Steam transmitted long distances with... condensation.
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ST. MARGARETS ROAD, ALTRINCHAM, CHESHIRE.
Telephone: ALTRINCHAM 3965.
Telegrams: TUBULARITY, ALTRINCHAM.
London Office: BUSH HOUSE, ALDW... W.C.2

ABBOTT & CO (NEWARK) LTD
Newark Boiler Wks
NEWARK
NOTTS
TANKS
See Displ... Advertise... July 24th

BRAITHWAIT...
PRESSED STEEL TAN...
BRAITHWAITE & CO. ENGINEERS...
London Office *Temporary Address:*
12, KINGS HOUSE, HAYMARKET, S...
Telephone: WHI 3993. Telegrams: Bromkirk-...

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25 COPTIC St., LONDON, W.C.1
MUSEUM 7460
SELF-CONTAINED UNIT
Hydraulic Pumps
ONE AND TWO STAGE TYPES
LOW AND HIGH PRESSURES

LIFTING MAGNETS **CHUCKS CLUTCHES**
RAPID MAGNETTING MACHINE COMP...
MAGNET WORKS LOMBARD ST. BIRMINGH...

BRICK MAKING MACHINERY
Herbert Alexander & Co Ltd
Charmouth St.
LEEDS.

HODGKINSON'S
PATENT
AUTOMATIC STOKERS
FORD LANE WORKS, SALFORD 6, LANCS

A Seven-Day Journal

Air Conditioning Apparatus in Tanks

IN reply to a question in the House of Commons, on Wednesday, July 29th, Mr. Oliver Lyttelton, the Minister of Production, dealt with the provision of air conditioning apparatus in tanks, a subject which has been widely discussed in connection with the Libyan and Egyptian campaigns. He stated that examination of captured enemy tanks did not afford any evidence of any refrigeration being used in German tanks. The widespread belief that they were so equipped had probably arisen from a recent illustration in the daily Press, purporting to show a refrigeration plant fitted in a German tank. This illustration was a diagrammatic picture, and not a photograph, and its examination by experts from two of the leading refrigerating machinery firms in this country, confirmed by the Design Department of the Ministry of Supply, showed that the scheme illustrated made no contribution to the problem of cooling tanks. The installation of any kind of refrigeration or air conditioning apparatus in a tank, desirable as it might be, raised serious problems of both space and weight. Nevertheless, the Ministry of Supply had set up a small panel in order to obtain all possible information on air conditioning equipment and its application to vehicles. The panel included both scientists and refrigeration experts. The Tank Design Department of the Ministry of Supply, moreover, maintained a section for physiological research in connection with tanks, which is composed of members lent by the Medical Research Council. Speaking in the House of Commons on Tuesday, August 4th, Mr. Lyttelton announced the names of those serving on the panel. They are as follows: —Mr. S. A. Wood, M.Sc., Senior Scientific Officer in the Ministry of Supply Scientific Research Department; Dr. Dorey, D.Sc., Wh.Ex., Member of the Council of the Institution of Mechanical Engineers; Chief Engineer Surveyor, Lloyd's Register; and Dr. E. Griffiths, D.Sc., F.R.S., Principal Scientific Officer in the Physics Department of the National Physical Laboratory. They consulted, he said, freely with appropriate specialists in other Government Departments and in industry on the various problems of research, development, and manufacture which arose in their inquiries.

Fuel Economy in Industry

THE Minister of Production, Mr. Oliver Lyttelton, has addressed letters to the managing directors of 30,000 industrial undertakings on the matter of fuel economy in industry. Enclosed in this letter is a note from the Ministry of Fuel and Power on coal supplies. In his letter the Minister of Production says that the Prime Minister is anxious that the seriousness of the coal position should be fully recognised throughout industry, and he has asked all his colleagues to enlist the support of industrial undertakings throughout the country in the measures of economy that are now necessary. In no other way, he states, can we maintain supplies for our essential industries and services, with all that that means for the successful prosecution of the war. In the enclosed note from the Ministry of Fuel and Power, he says a number of practical suggestions are put forward, all of which have the full support of the First Lord of the Admiralty, the President of the Board of Trade, the Minister of Supply, and the Minister of Aircraft Production, each of whom, the letter states, is anxious that the undertakings with which he is concerned should play their part with the rest of industry. The Ministry of Fuel and Power points out in its note that the country is faced for some time to come with a serious general shortage of coal, including the high-quality sized and cleaned coals, which have become increasingly popular with the development of specialised types of firing plant. However efficient the distribution of fuels may be, the maintenance of industrial production will, it is stated, depend on two things, first, the use of improved methods of fuel consumption, resulting in a decreased total demand, and, secondly, the increased utilisation by industry of the types of fuel not at present in general demand, of which supplies are less short. Every effort, the note adds, must be made to work combustion plant as economically as possible, whether for space warming, steam raising, or process work, and to reduce fuel requirements to the minimum. On the advice of the Ministry's Fuel Efficiency Committee and in collaboration with the Board of Education, discussion courses for management staffs and demonstrations for boiler-house operatives have been arranged at technical colleges and universities in some forty industrial areas.

Reopened Shipyards

ON Wednesday, August 5th, the Admiralty issued the following statement with regard to reopened shipyards:—At the present time it can be said that twenty-three of these establishments have been reopened in Great Britain and Northern Ireland. This action, in a few cases, actually took place before the war. In some instances the site has been developed as a separate ship-repairing establishment or it has been incorporated in an existing ship-repairing unit, but in twelve cases the old site is now in use for the purpose of building various types of craft, and including vessels exceeding 10,000 tons deadweight. A further yard is now being prepared for the purpose of building these larger vessels, and a still further yard of that class is under consideration for reopening. The policy of the Admiralty over a long period has been to provide additional berths and plant in most ample time ahead of the likely labour supply; in fact, because of the difficult labour situation the reopening of the old yards has, in the very great majority of cases, been necessarily associated with the prefabrication of a large proportion of the steel work spread over a very large number of units of the structural steel industry. A certain yard which the shipbuilding industry, through its National Shipbuilders' Security Scheme, had kept intact on a care and maintenance basis was, first of all, taken in hand and prepared ready for reopening as early as December, 1939, although it was not until early in 1941 that it was felt it could be reasonably manned. Quite a good number of other old shipyard sites are to-day being used by other industries, many of which are engaged on important war work and some on manufactures that are supplied to shipbuilding. In one instance, in a district very short of suitable labour for shipbuilding, the site is now in use as a seaplane base.

Control of Motor Fuels

IT is announced by the Ministry of War Transport that the Government has decided that in future no vehicle, whatever the fuel used, shall be allowed to operate for purposes which would not justify an issue of motor spirit or diesel oil. Since the outbreak of war, we may recall, the Government has rationed motor spirit, diesel oil, and certain home-produced liquid fuels, such as creosote. Vehicles operating on other fuels, such as producer gas, coal gas, steam, electricity, butane, and propane, have been allowed to have free access to whatever amounts of fuel that have been available. In view, however, of the need for conserving not only fuel, but vehicles, tyres, and man power, it has now become necessary to control the consumption by motor vehicles of fuel of every kind. This control will be effected by two Orders under the Defence Regulations. The first, which will come into force on Tuesday, September 1st, will prohibit the running of vehicles on fuels other than motor spirit or diesel oil except under a licence. Licences will be obtainable from the Regional Transport Commissioners of the Ministry of War Transport, and will be issued on condition that the vehicle is engaged on essential work for which road transport is necessary and that the fuel is available. The second Order, which will bring an "alternative fuel" rationing scheme into operation, will be issued in due course. Any inquiries from vehicle users about alternative fuels should be addressed to the Directorate of Producer Gas Vehicles, Ministry of War Transport, 2–3, Fitzmaurice Place, Berkeley Square, London, W.1.

A Proposed Economic General Staff

IN an address to the Engineering Industries Association on Thursday, July 30th, Sir William Beveridge raised the question of unemployment after the war, and suggested that the Government should set up an Economic General Staff to prepare the plans for assuring continued employment. There were, he said, three ways of winning a war—by our own speed and efficiency, by mistakes and unexpected weakness of the enemy, and by our own staying power. Whatever we might hope from the first two, we could not afford to neglect the third. The Government could strengthen staying power by convincing the people that they were taking reconstruction seriously. On the domestic side the aims of reconstruction were the destruction of want, disease, ignorance, squalor, and idleness. That would ensure to every citizen in return for service an income sufficient for his subsistence and his dependents, a national health service, better schools, and a development of adult education, better location of industry, and a revolution in housing. Idleness was the most important thing to attack,' and there must be no return to the mass unemployment that ruined so many lives between 1921 and 1939. In conclusion, Sir William said that we wanted the Government now to declare and to make us believe—(*a*) that it would be prepared to use the powers of the State to whatever extent might prove to be necessary in order to maintain employment after the war; and (*b*) that it had set up an Economic General Staff (a body that did not exist to-day) to prepare a plan or plans for that purpose, and to show just what would need to be done.

The Thames Barrage Scheme

IN view of war experience since 1940, which, it is stated, has amply confirmed a number of the contentions of the Thames Barrage Association, and the replanning of London by the Ministry of Works and Planning, that Association has addressed a request to Lord Portal, the Minister of Works and Planning, for further consideration of the removal of the tides from the London reaches as an essential feature of new plans. It has suggested a private inquiry in view of the Government's veto of public inquiry, as an effective method of obtaining reliable technical and economic evidence. The Association has also urged early action. The London County Council, to whom the Royal Academy's drawings and suggestions have already been sent, is to submit them for the Minister's approval. The request has been signed by Lord Desborough, a former Chairman of the Thames Conservancy Board; Lord Dudley; Sir Murdoch Macdonald, Past-President of the Institution of Civil Engineers; Sir Edwin Lutyens, President of the Royal Academy; Sir Giles Gilbert Scott, President of the Royal Institute of British Architects; Sir Edgar Bonham Carter, Chairman of the National Housing and Town-planning Council, and W. H. Gaunt, Chairman of the Mansion House Association on Transport; in conjunction with the Association's President and Chairman. Lord Portal has replied promising careful consideration and has suggested that official information be sent to the Corporation of the City of London and the London County Council as the authorities concerned with replanning, and the Ministries of Transport and Home Security, whose advice in the matter will be relevant.

Model Quality Control Charts

By H. RISSIK, A.M.I.E.E., M. Amer. I.E.E., A.I.I.A., F.R. Stat. S.

No. III

(*Continued from page 89, July 31st*)

Control Chart Analysis of Production Data

IN a letter to the Chairman of the War Preparedness Committee of the American Institute of Mathematical Statistics a prominent statistician recently pointed out that "there is no use in taking data if you do not intend to do something about the sources of the data." He was rightly arguing that the chief duty of the statistician is to present and interpret data in such a way that they convey knowledge for the purposes of prediction, and hence that one of the main aims of the statistical method is to help bring about necessary changes in the source which gave rise to the data.

Homogeneous data, that is to say, data obtained under stable or "controlled" conditions, may be analysed and presented in an extremely simple fashion, as has been pointed out in a previous article.[17] In fact, from a practical standpoint, all the essential information contained in such data is preserved in the total number of observations N, their mean value $\overline{X}$, and their standard deviation σ. The order in which the data were taken then no longer contributes to our essential knowledge of their source. But in the case of data of an obviously heterogeneous character, or whose apparent homogeneity is for any reason suspect, a routine statistical analysis to determine $\overline{X}$ and σ is almost valueless from the point of view of "doing something about the sources of the data." Where, as in such a case, the observations are not obtained under the same essential conditions, *i.e.*, conditions in which only random causes of variation are operative, the order in which the observations were taken is a vital factor in detecting assignable causes of variation. It is here that the control-chart method of analysis is particularly valuable as a means of "doing something"—of identifying assignable causes of variation and, through their elimination, of bringing the "sources of the data" into a state of statistical control or uniformity.

While the ultimate and most important function of the control chart is to provide a definite operational procedure for controlling product quality during actual manufacture, its use as an analytical tool in production process investigations is something which the engineer can ill afford nowadays to overlook. Here, again, the model quality control chart, constructed from Tippett's random sampling numbers, furnishes a convenient means of illustrating the principles involved. Reverting to the hypothetical capstan operation producing a nominal piecepart dimension of 0·125in., subject to a tolerance of ±0·003in., and which we discussed in connection with Figs. 3 and 4 (*ante*), let us now suppose this process operation to be transferred to a five-spindle automatic working continuously throughout three eight-hour shifts. With a production rate of 200 pieceparts per hour, a reasonable process inspection procedure for such a machine would be to inspect twenty-five parts every two hours, taking five parts from each spindle.

The inspection data for this process operation, and the control charts for sample means and ranges derived therefrom, are shown in Fig. 5 for the case of "quality controlled" production. The data and charts cover a full twenty-four hours' operation and comprise 300 observations grouped into 60 successive samples of 5 observations each. Samples Nos. 1, 6, 11, &c., relate to spindle No. I; samples Nos. 2, 7, 12, &c., to spindle No. II; samples Nos. 3, 8, 13, &c., to spindle No. III; samples Nos. 4, 9, 14, &c., to spindle No. IV; and samples Nos. 5, 10, 15, &c., to spindle No. V. The 60 samples of 5 were obtained by using the first 30 blocks of random sampling numbers on the second page of Tippett's table, in conjunction with column A of Table III (*ante*).

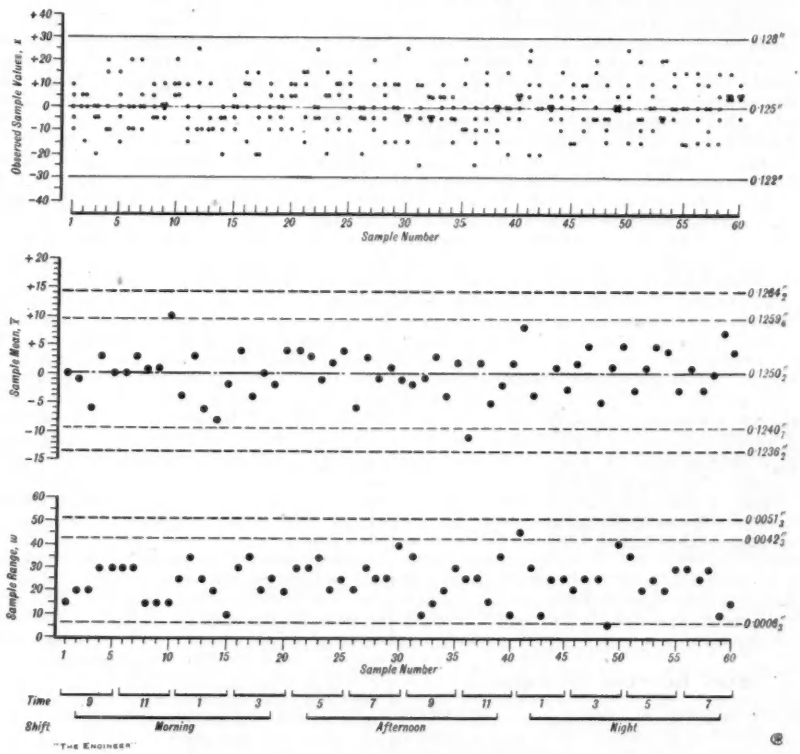


FIG. 5

The process average is in this case found to be $\bar{\bar{x}}=0\cdot15$ as compared with the true value $\overline{X}=0$, while the observed mean range $\bar{w}=24\cdot25$ gives an estimated standard deviation for the process of $\hat{\sigma}=10\cdot4$, as compared with the true value $\sigma=10$. Here, again, it is evident that under conditions of quality controlled production the results of sampling inspection (in this case only 6 per cent.) give all the essential information contained in the results of a detailed inspection of the product. The control charts of Fig. 5 include an inner pair of "warning" limits, spaced at the "2-sigma" distances on either side of the mean value ($\bar{x}$ or $\bar{w}$), in addition to the conventional "3-sigma" limits which are used as "action" limits in attaining control of product quality.[18] Under stable conditions not more than about one plotted point in twenty should fall between the inner and outer control limits. Both the chart for "means" and the chart for "ranges" show only 2 out of the 60 points in this position, and neither chart therefore gives a warning indication of any imminent lapse of control.

Investigation of an Unstable Production Process

Having considered the control-chart method of analysis as applied to a stable production process, let us now turn to the examination of a further series of data, relating to the same five-spindle automatic, as might be obtained, say, at a later date. The process inspection results are shown plotted in the upper diagram of Fig. 6, and it will be seen that five defective pieceparts were observed during the twenty-four-hour period. To what assignable cause or causes must this deterioration in product quality be attributed? An increase in the rate of defective production from zero to just under 2 per cent. certainly calls for investigation.

In conducting such an investigation the control-chart method of analysis is, as we shall see, a most valuable weapon of attack. The control charts, based on the 60 samples of 5 depicted in the upper diagram, are shown in the middle and lower diagrams of Fig. 6. Both charts show conclusive evidence of a lack of control in the production process. Sample No. 41 gives a point on the "range" chart outside the 3-sigma action limit, whilst sample No. 51 gives a similar point on the chart for "means." Note that each of these samples included a defective piecepart.

What of the three remaining defective pieceparts? Do the control charts give any indication? Not directly, for these three parts were only just outside the specified tolerance limits 0·125±0·003in. But indirectly we do get some indication on the "range" chart. The defective samples were Nos. 1, 11, and 31, and in each case the point on the chart for "ranges" fell either outside or just inside the upper 2-sigma warning limit. Moreover, the points for samples Nos. 16 and 21 also fell just inside this warning limit. Now it will be noted that all these

[17] *Vide* Reference (3).

[18] *Cf.* B.S. 1008—1942, Section 11.

sample numbers relate to spindle No. I, and we are therefore led to conclude that the cause of our five defective pieceparts is due to a somewhat higher process variability associated with this particular spindle.

At the same time it has to be borne in mind that, considering the "range" chart in this way, samples Nos. 30 and 47 are just as significant pointers to lack of control as is, say, sample No. 11. In their case the process variability seems abnormally low, which may

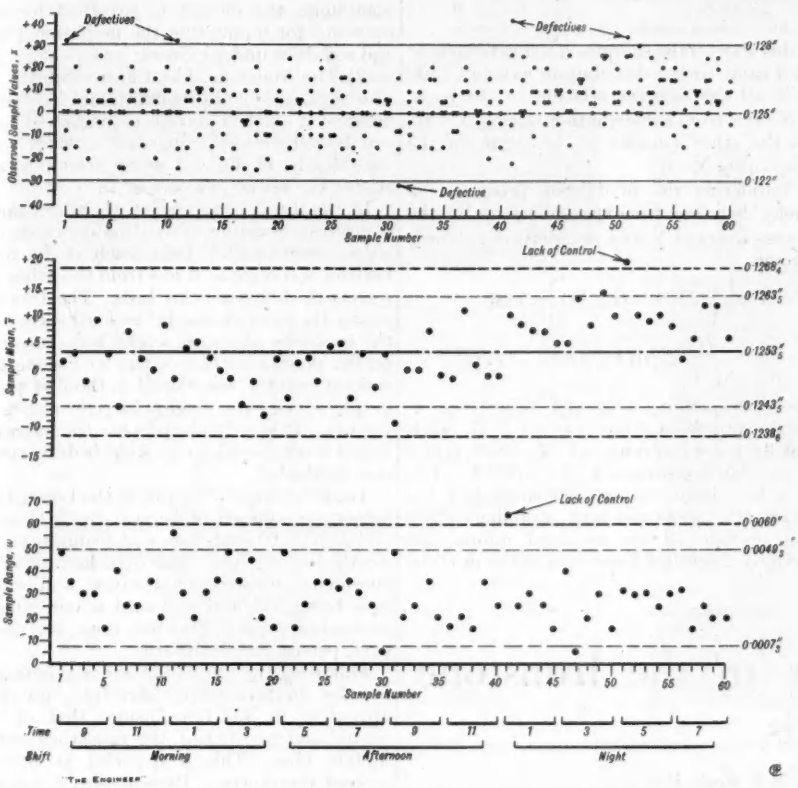


FIG. 6

or may not be due to chance. Looking at the chart as a whole, however, the occurrence of 3 points in 60 between the inner and outer pairs of control limits, coupled with the occurrence of 4 more points just inside the upper warning limit, lends support to the evidence (provided by the "action" point for sample No. 41) that the process variability is no longer as uniform as it was in the case of Fig. 5. At the present stage of the investigation we merely suspect that this is due to some cause associated with spindle No. I.

What of the control chart for "means"? Here three points (samples Nos. 19, 31, and 49) lie between the inner and outer limits, one (sample No. 6) lies on one of the inner limits, while two more (samples Nos. 17 and 47) lie just inside them. Such a total of six points in 60 is corroborative evidence for lack of uniformity in the general process level, which was clearly indicated by the point for sample No. 51. Now the abnormally high average x for this particular sample occurs in conjunction with a sample range w quite near the average $\bar{w}$. Hence all five sample values x were higher than usual, as may be seen from the upper diagram in Fig. 6. This leads us to conclude that the general process level has risen significantly. A glance at the control chart for "means" shows that this is the case for the second half of the twenty-four-hour period, *but more especially for the last twenty samples*. Now these particular samples were all taken during the night shift. Hence we suspect, at this stage of the investigation, that the general level of the production process became abnormally high towards the end of the afternoon shift.

ANALYSIS BY RATIONAL SUB-GROUPING

A control-chart analysis based on the normal process inspection routine, viz., a sample of five pieceparts taken every two hours from each of the five spindles, thus gives us a fairly clear lead as to the nature of the assignable causes at work in this particular case. On the one hand, the variation of sample means $\bar{x}$ suggests a general upward movement in piecepart dimension between the afternoon and night shifts. On the other hand, the variation of sample ranges w seems to indicate that spindle No. I contributes more towards the aggregate process variability than the remaining spindles of the automatic.

The final stage in the investigation therefore must consist in a renewed analysis of the data in such a way as definitely to associate possible assignable causes with specific groups of observations. Such a method of analysis is based on what Shewhart has described as the division of the data into "rational sub-groups"; that is to say, sub-divisions *within* which there are reasons for believing the variations to be purely random, but *between* which there may be some differentiation due to the operation of assignable causes. In our present example, illustrated by Fig. 6, two alternative ways of rational sub-grouping are already evident. One way is to sub-divide the 300 observations into five sub-groups of 60, each sub-group comprising the twelve samples of five taken from one spindle. The other way is to sub-divide the 300 observations into three sub-groups of 100, each sub-group comprising the twenty samples of five taken during one shift. The former method of sub-division—sub-grouping by "spindles"—is shown in Table V (*a*) and provides the basis for a decisive control-chart test for differences between the five spindles. The latter method—sub-grouping by "shifts"—is shown in Table V (*b*), and in turn leads to a similar test for differences between the three shifts.

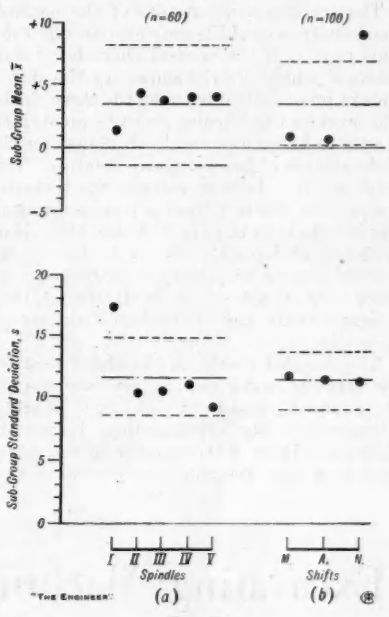


FIG. 7

TABLE V.—*Analysis by Rational Sub-Grouping*

(*a*)

Sample numbers.	Spindle.	Mean, $\bar{x}$.		Standard deviation, s.	
		Observed.	Expected.	Observed.	Expected.
5m–4	I	1·47	3·33	17·23	16
5m–3	II	4·33	3·33	10·17	10
5m–2	III	3·75	3·33	10·35	10
5m–1	IV	3·91	3·33	11·00	10
5m	V	3·91	3·33	9·05	10
m=1, 2, . . 12	Mean value:	3·47	3·33	11·56	11·2

(*b*)

Sample numbers.	Shift.	Mean, $\bar{x}$.		Standard deviation, s.	
		Observed.	Expected.	Observed.	Expected.
1–20	M	0·95	0	11·42	11·2
21–40	A	0·39	0	11·35	11·2
41–60	N	9·09	10	11·11	11·2
	Mean value:	3·47	3·33	11·29	11·2

The two relevant control charts are illustrated in Fig. 7. In view of the large sub-group size (n=60 and n=100 respectively in the two cases), it is no longer possible to use the range w as a measure of variability within the sub-group, and recourse must be had instead to the sub-group standard deviation s for determining the control limits. The control charts of Fig. 7 are thus charts for

"means" and "standard deviations."[19] Fig. 7 (*a*) shows the results of the control-chart analysis by spindles. As is to be expected, there is no evidence of lack of control as far as the general process level is concerned. All five "spindle means" lie well within their 3-sigma limits and differ but little among themselves. But when it comes to considering the general variability of the production process in terms of the contribution from each spindle, the control chart shows us quite a different picture. As we suspected from Fig. 6, spindle No. I contributes far more than the others, and the control chart for "spindle s.d.'s" shows this up in a most decided manner.

The corresponding results of the control-chart analysis by shifts are shown in Fig. 7 (*b*). This time it is the control chart for "shift means" which clearly shows up the difference in process level between the three shifts. The level for the morning and afternoon shifts is seen to be quite normal, while that for the night shift is higher by nearly 0·001in. This confirms in a decisive manner the tentative conclusions reached from a consideration of Fig. 6. As is to be expected also, there is no evidence of lack of control as far as the general process variability is concerned. All three "shift s.d.'s" lie well within their 3-sigma limits and differ but little among themselves.

The detailed results of the above analyses by rational sub-grouping are summarised in Table V under the column headings "Observed". The corresponding "Expected" values are those determined from the actual model of the unstable production process used in constructing Fig. 6. The method of construction adopted was the same as in the case of Fig. 5, the 60 samples of five being obtained by using the first 30 blocks of random sampling numbers on the third page of Tippett's table. This time, however, all four model frequency distributions of Table III were utilised, in accordance with the following scheme:—

Sample Nos. 1, 6, 11, 16, 21, 26, 31, and 36	Column C
Sample Nos. 41, 46, 51, and 56 ...	Column D
Sample Nos. 42–45, 47–50, 52–55, and 57–60	Column B
All remaining samples	Column A

In this way all the samples relating to spindle No. I came from a distribution having $\sigma=16$, while all the samples relating to the night shift came from a distribution having $\overline{X}=10$. For the other spindles, $\sigma=10$, while for the other shifts $\overline{X}=0$.

Considering the production process as a whole, therefore, the expected values for the process average $\overline{X}$ and standard deviation σ become

$$\overline{X}=\frac{1}{3}\left[(2\times 0)+(1\times 10)\right]=3\cdot 33$$

$$\sigma=\sqrt{\frac{1}{5}\left[4\,(10)^2+(16)^2\right]}=11\cdot 46.$$

The corresponding observed value (Fig. 6) for the process average was $\overline{\overline{x}}=3\cdot 47$, while that for the mean range was $\overline{w}=28\cdot 3$, giving an estimated process s.d. of $\hat{\sigma}=(28\cdot 3/2\cdot 326)=12\cdot 17$. Here we see once more how the results of a mere 6 per cent. sampling inspection provide all the essential information given by a detailed inspection of the product.

[19] *Vide* Reference (3) for rapid methods of calculating the sub-group means $\bar{x}$ and standard deviations s when n is large. See also Instruction Sheet 2 of B.S. 1008—1942 and Section 6 of B.S. 600R—1942.

Excavating Machinery in the Ironstone Fields

By W. BARNES, M.I. Mech. E.

No. I

Introduction

IT is doubtful whether any industry using excavating machinery has such a variety of problems to deal with, and in consequence can record such interesting uses and developments for this class of machinery, as the open-cast ironstone workings in the Jurassic Measures, which extend in more or less broken lines south-south-west from Frodingham in North Lincolnshire, through Lincolnshire, Leicestershire, Rutland, Northamptonshire, Oxfordshire, into Wiltshire.

The cover or overburden which must be removed to obtain access to the stone, an operation commonly known as stripping, varies in depth from about 2ft. to as much as can be economically removed, the maximum at the present time being about 85ft. The material ranges from loose sand to thick beds of limestone. Frequently it consists of a series of superposed sands, limestones, and clays, often with heavy boulder clay capping the whole.

The biggest problem is the removal of increasing depths of heavy overburden. This material, coupled with big working depths, involves the use of large powerful excavators with long dumping radii, in order to deposit the excavated material on to the ground from which the ironstone was removed on the previous cut, and in many quarries where the depth and nature of the overburden makes it practicable, restoring the worked-out ground to enable it to be put back into cultivation. The latter means not only levelling the surface, but replacing the subsoil and top soil in their correct relative positions.

Other difficulties are:—

(1) The varying quantities of ironstone required from many of the mines owned or leased by iron and steel companies who operate the properties to suit the requirements of their own blast-furnaces, as the analysis is frequently not constant, even in a restricted area. To obtain the best results, ore from more than one source has therefore to be used in the burden of a blast-furnace. Sometimes the output is governed by the necessity for liquidating the minimum rents and royalties under existing leases.

(2) The ironstone, like the overburden, is also very variable in its depth and hardness. Some of it on the outcrops is weathered, and can be very easily excavated; others consist largely of bedded stone which necessitates the use of explosives.

In the Jurassic formation there are three deposits of ironstone of outstanding economic value, occurring as beds, each in its own horizon and separated one from the other by a great thickness of other beds. The Jurassic strata dip gently towards the south-east, and the ironstone and intervening beds crop out on the present surface of the land along the strip of country, mentioned in the first paragraph, which runs roughly at right angles to the dip. It is only at and near the outcrops that it is practicable to work the beds by open-cast methods.

The lowest bed, occurring in the Lower Lias formation, appears on or near the surface in and around Frodingham and Scunthorpe, in North Lincolnshire, where it has attained enormous industrial importance, and where it is being followed eastward under rapidly increasing cover. The bed does not, however, persist far southward.

Following the line of the Jurassic outcrops in the south-westerly direction we find appearing in Mid-Lincolnshire that of the second and higher bed, the marlstone of the Middle Lias. This is quarried at present around Caythorpe. Passing into Leicestershire, we find important and very extensive workings in the marlstone at Harston, Knipton, Branston, Eaton, and Eastwell. Continuing south-westwards, a great open-cast area north of Melton Mowbray has been worked out, though underground mining is now in progress at Holwell. As we still pass on in the same line, the outcrop is still a

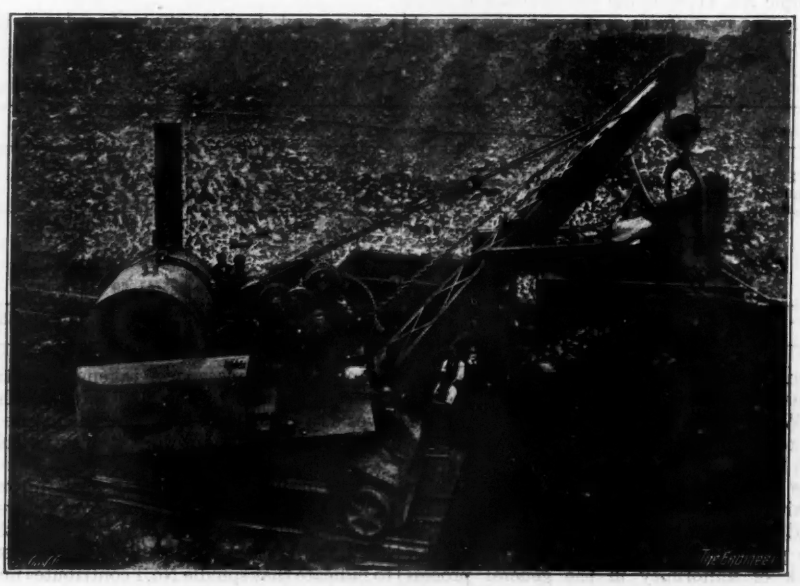


Fig. 1—Wilson Steam Navvy, 1895

feature, although it is not continuous and the stone is not rich enough in iron to be classed as an ore, with the exception of a small exposure near Tilton. It is not until we reach Oxfordshire that we again find it being quarried as ironstone. Here it is being worked near Banbury, around Wroxton, and at Bloxham, Adderbury and Hook Norton, south of Banbury, and at Charwelton and Byfield, north of Banbury, and west of Northampton.

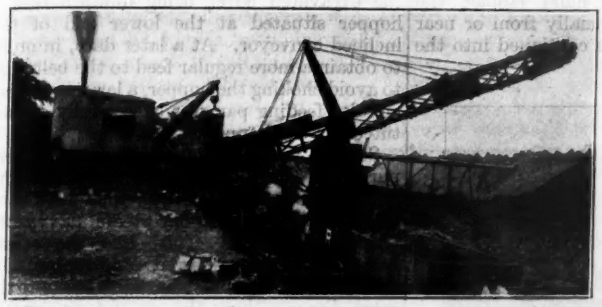
A varying thickness, up to at least 120ft., of Upper Lias clay separates the marlstone from the topmost and third bed of ironstone. This is known as the Northampton Sand bed. The outcrop appears at Greetwell, near Lincoln, and runs east of the marlstone outcrop, following it at the higher level in the same south-westerly direction. The bed is very variable from one locality to another and sometimes is merely sandy material, but over very extensive areas we have in the lower portion of the bed an extremely valuable ironstone.

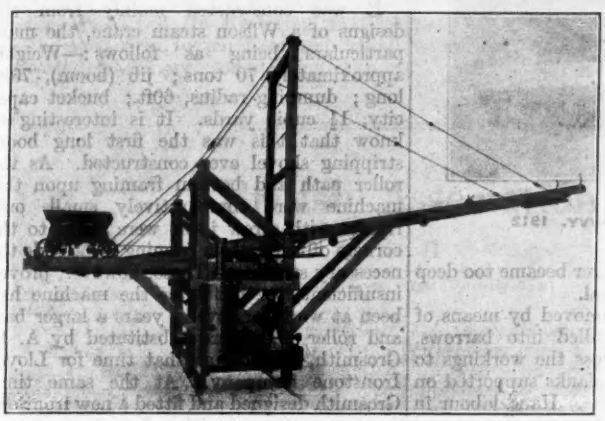
At the present day the most northerly opencast workings are at Harlaxton, 4 miles southwest of Grantham. Passing southward, quarries are now being worked at Colsterworth and Stainby, in South Lincolnshire, at Market Overton, Cottesmore, Burley, and Pilton, in Rutland, at Nassington, Barrowden, Harringworth, and numerous places around Corby, Kettering, Islip, Wellingborough, Lamport, Brixworth, and Pitsford, north of Northampton, and Blisworth and Towcester, south of Northampton.

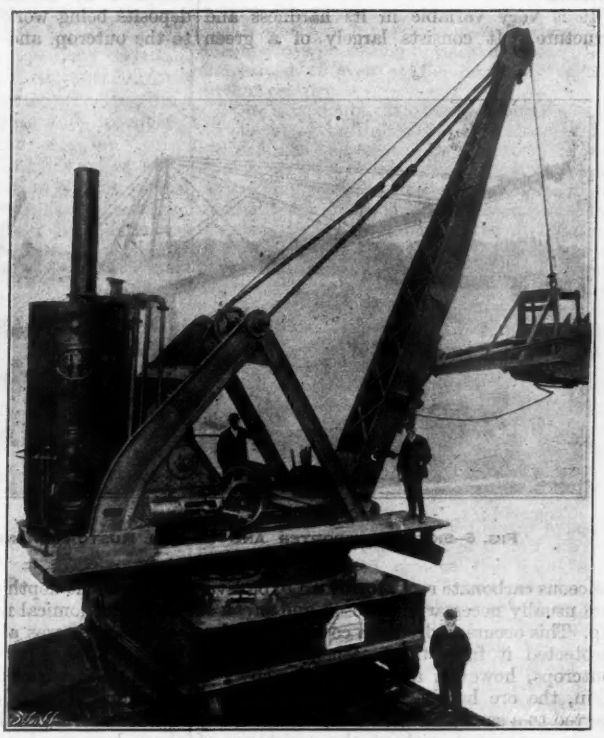
The Frodingham ironstone consists mainly of ferruginous limestone, which requires the use of explosives to loosen and break it up, excepting near the outcrop, where it is thinner and well weathered. It contains only about 22 to 23 per cent. iron, with 17 to 20 per cent. lime, and 8 to 12 per cent. silica. The lime content is high and greater than is required as a flux, and it is therefore necessary to add a proportion of ironstone having a low lime content to the calcareous Frodingham ironstone in order to obtain the best results from the blast-furnaces. The thinner overburden consists chiefly of sand and easily excavated soil, varying from about 1ft. thick on some of the outcrops to as much as can be economically removed, but as the overburden becomes deeper, a band of clay, which becomes progressively thicker, appears. At present the maximum depth is 55ft. to 60ft., where the ironstone runs under adjacent hills. Unfortunately, as the ground rises the ironstone dips, so that at some time in the not too distant future resort will be had to underground mining. At the same time it is more than likely larger excavators will be installed to deal with cover deeper than is being removed or even contemplated at the present time.

The marlstone of the Middle Lias has a low iron content, generally speaking, and, like the Frodingham bed, it generally has a high lime content. It is, nevertheless, a very valuable ore for adding to the more siliceous Northampton Sand ironstone. An average analysis is 25 per cent. iron and 10 per cent. each of silica and lime.

The largest outputs are obtained from the workings around Wroxton, near Banbury, where the overburden is only from about 1ft. to 6ft. thick. In the deeper workings Upper Lias clay is met with, a compact shaly material which is sometimes covered with a deposit of boulder clay. Occasionally the boulder clay may lie directly on the ironstone. The deepest working at present is in the Leicestershire marlstone at Eastwell,







FIGS. 2, 3, AND 4—WILSON BELT CONVEYOR, 1897, WHITAKER TIMBER SKIP CONVEYOR, 1904, AND WHITAKER 20-TON NAVVY, 1904

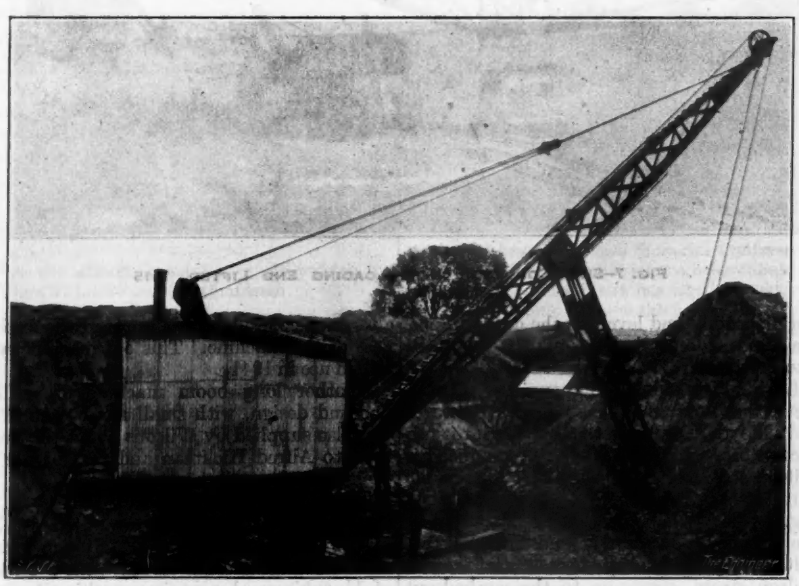


FIG. 5—WILSON LONG JIB CRANE NAVVY, 1899

where the cover at one end of the working face reaches a depth of 40ft.

Most of the ironstones in the marlstone deposits are very compact, and somewhat similar in appearance to the Frodingham ironstone, and explosives are necessary to loosen and break them up.

The ironstone of the Northampton Sand bed is by far the largest and most important deposit which is being worked in Great Britain.

It is very variable in its hardness and structure. It consists largely of a green

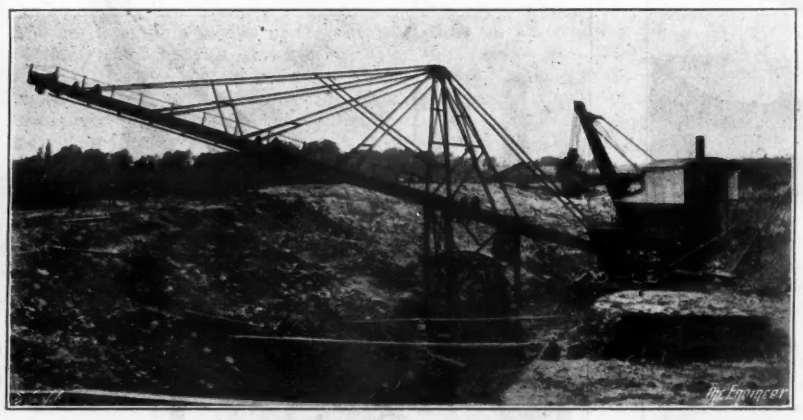


FIG. 6—SKIP TRANSPORTER AND 15-TON RUSTON CRANE NAVVY, 1912

siliceous carbonate rock, for which explosives are usually necessary to loosen and break it up. This occurs under deep cover, which has protected it from the weather. Near the outcrops, however, and where the cover is thin, the ore has been weathered and converted to a sandy brown oxide, which is very easily excavated without the assistance of explosives.

The iron content is fairly constant at from 28 to 34 per cent., which is the highest of the ironstones in the Jurassic Measures. The silica and lime contents are very variable, however, and run usually from 6 to 18 per cent. silica and 1 to 8 per cent. lime. The "non-limy" stone is very useful to mix with the "limy" Frodingham stone. The cover is composed of the very variable beds of the oolites and varies greatly in depth from about 3ft. to 100ft. and in composition from sand to limestone. Examples of shallow cover are the workings at Buckminster, Stainby, Sewstern, and Cottesmore, where the ground is all carefully levelled and restored for cultivation after the ironstone has been removed, in a manner described later. As a contrast to the easy shallow cover, and sometimes adjacent to it, the Northampton Sand ironstone is occasionally covered with a deposit mainly consisting of Lincolnshire limestone up to 40ft. in depth, which adds greatly to the cost and difficulty of stripping, as instanced by workings at Colsterworth and Sproxton. In other quarries the cover may consist mainly of sand or of superficial layers of sand and clay, some of it including a varying proportion of limestone beds, whilst in the vicinity of Corby, Northants, the cover runs to a depth approaching 100ft. and consists largely of boulder clay, which is hard to dig and treacherous to deal with because of its liability to slip.

The foregoing remarks apply to present-day conditions. Generally speaking, the quarry companies are working the easily got ore near the outcrops and there are many instances where the depth of overburden is the controlling factor as regards the length of face. In many ways the present open-cast methods of obtaining iron resemble what took place when coal was first found to have a commercial value, it being then obtained from small open-cast pits, although, of course, excavating machinery and the railway systems have had tremendous influence on present-day developments in the ironstone fields.

Up to the year 1895 all the ironstone was obtained by means of hand labour, the deposits being worked usually from or near to the outcrop, and then continued into the bed until the depth of cover became too deep for its economical removal.

The cover was also removed by means of hand labour. It was filled into barrows, which were wheeled across the workings to the dump side on long planks supported on trestles of varying heights. Hand labour in those days was both cheap and efficient and most of the materials were excavated by piecework for from 3d. to 4d. per cubic yard, which included not only excavating and wheeling them on to the dump side, but in some instances removing the top soil and sub-soil separately and levelling the ground upon the dump side so that it could be put back into cultivation.

Lloyds Ironstone Company, of Corby, Kettering, now amalgamated with Stewarts and Lloyds, Ltd., were the first to use excavators. In 1895–96 they introduced a Wilson steam crane navvy with a 1½ cubic yard bucket for digging the ironstone—Fig. 1. They then turned their attention to the problem of stripping and introduced a belt conveyor to dump the material from a Wilson steam navvy on to the worked-out ground—Fig. 2. This conveyor was constructed by the makers of the Wilson excavator, John Wilson and Co., Ltd., of Liverpool. The original design consisted of a sectional plate conveyor, but because of the heavy weight and wear and tear upon the conveyor sections it was altered by Rubery, Owen and Co. to a belt type of conveyor, acting on the instructions of Lloyds Ironstone Company, who continued to use it in conjunction with the Wilson steam navvy, the excavated cover being dumped into a hopper situated at the lower end of the inclined conveyor. At a later date, in order to obtain a more regular feed to the belt, and to avoid choking the hopper, a large revolving circular feeding pan was successfully substituted for the hopper.

Several more Wilson crane navvies were purchased by Lloyds Ironstone Company between 1895 and 1900. In 1899–1900 they introduced a long boom steam navvy for stripping—Fig. 5. This, like the steam navvy previously referred to, was built by Wilsons, but had sufficient radius to dump the cover direct without the use of a conveyor.

It was constructed mainly from the designs of a Wilson steam crane, the main particulars being as follows:—Weight, approximately 70 tons; jib (boom), 70ft. long; dumping radius, 60ft.; bucket capacity, 1½ cubic yards. It is interesting to know that this was the first long boom stripping shovel ever constructed. As the roller path and bottom framing upon this machine were comparatively small, outriggers with screw jacks were fitted to the corners of the bottom framing to provide the necessary stability. These, however, proved insufficient, so that after the machine had been at work for several years a larger base and roller path were substituted by A. R. Grosmith, engineer at that time for Lloyds Ironstone Company. At the same time, Grosmith designed and fitted a new front end digging equipment with a dumping radius of 75ft. to take the place of the Wilson equipment. Grosmith's equipment consisted of a light boom and bucket arm with a rope crowd to the latter. He also fitted separate steam engines for the swing motion. These alterations considerably improved the usefulness of the machine. This old machine was still in use in 1941.

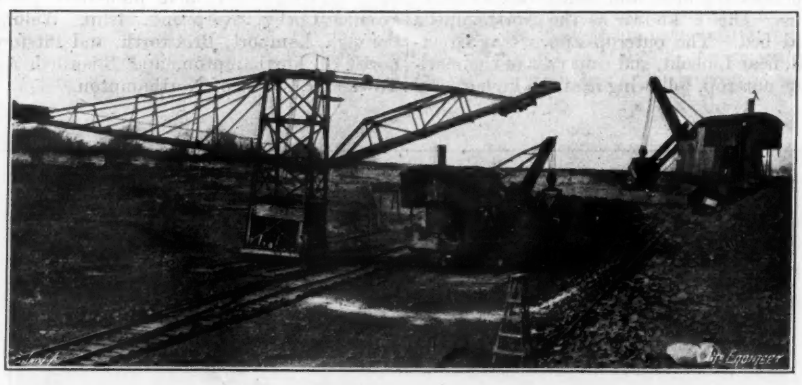


FIG. 7—SKIP CONVEYOR WITH LOADING END LIFTED, 1915

Another long boom machine of similar size and design, with small roller path, &c., was also supplied by Wilsons about the same time to Alfred Hickman and Co. for use in their ironstone mines near Banbury.

The next move was made in 1904 by E. P. Davis, of Ilkeston, who installed in his quarries at Glendon, near Kettering, a 12-ton Whitaker steam crane navvy with a bucket of 1½ cubic yard capacity, working in conjunction with a skip type of conveyor—

Fig. 3. The advantage of the skip compared with the belt is that the dumping point can be varied at any desired point along the inclined rail track by means of an adjustable tripping jack to enable the ground to be roughly levelled on the dump side, whereas the belt type dumps only at the end of the conveyor, which leaves the ground on the dump side in a series of peaks or "hills and dales." This conveyor was constructed throughout of heavy timbers and, like the belt type of conveyor used by Lloyds, was mounted on double-flanged wheels to run on rails laid on timbers in the bottom of the cutting.

In 1904 E. P. Davis installed a larger steam crane navvy for digging ironstone, viz., a 20-ton Whitaker—Fig. 4. This machine weighed 70 to 75 tons and was fitted with a 3–3½ cubic yard bucket. For some reason or other, probably because it was such a cumbersome machine, this was the only excavator of this size constructed, but it was the forerunner of larger and heavier machines for digging ironstone which have been installed in recent years.

James Pain, Ltd., of Kettering, in 1906 was the next firm to purchase and install excavating machinery, commencing with a 12-ton Whitaker steam crane navvy similar to the one installed by E. P. Davis.

The Sheepbridge Coal and Iron Company also followed suit in 1907 and installed a Whitaker 12-ton steam crane navvy and a skip conveyor similar to the one purchased by E. P. Davis.

The old Whitaker skip conveyor, made of timber, although effective up to a point, had a short dumping length and was cumbersome and heavy. The Wellingborough Iron Company therefore installed in 1912 an all-steel skip conveyor, supplied by Ruston, Proctor and Co., to work in conjunction with a Ruston No. 16 crane navvy. The conveyor was made by Heenan and Froude to the specification of Rustons—Fig. 6.

In the same year the Holwell Iron Company also installed a small Ruston "light steam shovel" with ¾ cubic yard bucket to work in conjunction with an all-steel skip conveyor made by Fraser and Chalmers to the order of Ruston, Proctor and Co. The loading end of the conveyor was designed so that it could be raised to enable the ironstone digger to pass under the conveyor at the end of the cut—Fig. 7.

(To be continued)

British Association

No. II

(Continued from page 93, July 31st)

AT the end of the Conference on Mineral Resources, held by the British Association on July 24th and 25th, the following resolution was unanimously passed :—

"That this Conference on Mineral Resources and the Atlantic Charter, convened by the British Association's Division for the Social and International Relations of Science, request the Council of the Association to consider means by which the Association could assist in the carrying out of the Fourth Article of the Atlantic Charter, which postulates access for all States on equal terms to the raw materials of the world.

"This Conference, having specifically dealt with mineral resources, submits that, as a first step, the Council should initiate forthwith consultations with appropriate scientific and technical organisations, to secure an understanding on the principles involved. The Conference would further urge that a scientific review of mineral resources, using and supplementing all existing data, should be among the first tasks of any international organisation for the social applications of science, such as was envisaged at the recent Conference on Science and World Order. To this end, the Conference recommends that the Council should consider how it might help to promote the establishment of an International Resources Organisation, as a fact-finding and advisory body for Governments, as a contribution to world stability, and in the spirit of the Atlantic Charter."

For the afternoon session on July 24th Sir William J. Larke was the Chairman.

Opening Address by Sir William J. Larke,

There are many elements (available in such small quantities that they are properly described as "rare," *e.g.*, tin, tungsten, and nickel), which exert a profound influence on our modern life, and consequently on the military strength of the countries which know how to use them and can obtain them. In these days of ever-increasing rapidity of transport, under peace conditions it would seem to be possible for all nations to obtain access to the raw materials they require (irrespective of their geographical location), if willing to pay the world price for them. This has been fully borne out by the large stocks of essential metals—such as tungsten, nickel, and chromium—which Germany was able to accumulate before the outbreak of the present war, none being available in Germany.

The greatest need for the post-war period appears to be accurate knowledge as to the essential minerals on which the material well-being of mankind is based, particularly the correlation of the vast amount of existing knowledge in a statistical form which will enable effective comparison to be made as to the progressive development in the different countries, as on such knowledge alone can an effective policy, either national or international, be devised in respect of the distribution of mineral resources. In spite of the wealth of information which is published by different authorities, we are frequently still unable to ascertain with accuracy economic information of the known mineral occurrences, even of the United Kingdom, which has been the home of mining and was for centuries one of the principal sources of supply of non-ferrous metals to the Old World for upwards of 1000 years.

While the Mineral Resources Department of the Imperial Institute, which is the centre for this collection and dissemination of information, including statistics, of the mineral resources of the Empire, is maintaining the collection of statistics (although under present conditions they are not available for publication), great difficulty has been experienced in the past in securing statistics from the different Dominions and Colonies on a comparable statistical basis. At two Imperial Conferences proposals were made that such a basis should be established, but so far it has not been accomplished. It would involve the full collaboration of the commercial mining interests responsible for mineral development within the Empire, but this, it is believed, can be readily secured. It will be obvious that such information will be necessary for the effective regulation of the distribution of the minerals, and it is to be hoped that the efforts which the Imperial Institute is making will prove ultimately successful. So far there have been local difficulties in the different countries in achieving this common basis.

The Fourth Clause of the Atlantic Charter, however, still has an important bearing on future policy in that it is a pledge that no restrictions will be placed on access by all nations to raw materials. This may have a much more important bearing on the future than we at present realise, since in the light of present knowledge, the deprivation of certain metals (such as tungsten, nickel, and chromium) would make a nation almost defenceless against others which could obtain them. There is strong evidence that we are passing through another Industrial Revolution based on an ever-increasing understanding of the potentialities of alloys of basic metals (such as iron, aluminium, and copper, with small and even minute proportions of other elements), which completely change the physical properties of the basic metals with which they are alloyed, thus producing alloys possessing physical characteristics undreamed of even at the beginning of the present century.

There is no doubt that the economic co-operation between the United Nations envisaged by the Atlantic Charter will be essential if world recovery is to be accomplished within a generation. Therefore the national organisation of production of all kinds is a condition precedent to international regulation of the distribution of the products. This will apply particularly to raw materials, whether mineral or agricultural. The production of such materials is to some countries the basis of their economic life, and unless they can be exported to countries able to use them, hardship and a fall in the standard of life of those countries becomes inevitable.

However desirable the doctrine of *laisser faire* may have appeared in a world emerging from a state of primitive individualism, it is obvious that its general application under to-day's conditions would be the denial of the intelligent application of the results of experience.

The fact that the Atlantic Charter appears to envisage such regulation is of the utmost importance, but to achieve the result will involve "give and take" and sacrifice at the outset to a greater or lesser extent on the part of all participating nations. The ultimate result of such a policy to the extent that it can be achieved would unquestionably benefit all the participating nations and ultimately raise the standard of life for mankind as a whole. It would also create world conditions under which the chances of maintaining peace would be greatly enhanced, since some, if not most, of the economic causes of war would be adjusted by agreement as they arose.

Tin Deposits, by Professor W. R. Jones

All the known occurrences of tin deposits, whether of primary origin in the form of lodes, disseminations, and so forth, or of secondary origin as alluvial or eluvial deposits, are genetically related to granite or to rocks of the granite family, such as pegmatites, associated magmatic quartz veins, aplites, quartz porphyries, and rhyolites.

The world's tin fields can be resolved into a few groups, conveniently termed "metallogenetic tin provinces," in which the tin mineralisation with respect to each group was effected at the same time and under similar conditions. Outside these provinces, no tin deposits of economic importance are known and the evidence is very strong, almost conclusive, that only in those few parts of the earth's crust were conditions suitable for the deposition of cassiterite, the mineral which is the source of almost all the world's tin.

The bulk of the metal in normal times was obtained from alluvial and eluvial deposits which were fast becoming exhausted, and less than a quarter of the metal supply came from lode mining. As in the case of gold, where formerly the production was mainly from auriferous gravels, which now produce only a small percentage of the world's gold, so in the future will lode mining become the main source of tin production.

It is likely that few tin fields remain to be discovered, but greater attention will be devoted to lode mining on a larger scale.

The World's Manganese Ore Deposits and the Atlantic Charter, by Sir Lewis Leigh Fermor, F.R.S.

For a mineral substance to be described as manganese ore without qualifying adjectives, such as "ferruginous," it should contain not less than 40 per cent. of metallic manganese.

The lower limit for first-grade ore was formerly 50 per cent. and is now 48 per cent., but a large proportion of the manganese ores of commerce contain at least 50 per cent. of the metal. On the other hand, the earth's crust contains on the average only 0·10 per cent. of manganese oxide (MnO). This means that Nature, in producing these commercially usable ores, has concentrated the originally widely dispersed element to the extent of some 500 times.

Though manganese ores are produced by more than forty countries, only seven have yielded on the average over 100,000 tons annually during the last quinquennial period before the present war, 1934–38, as is shown by the following figures :—

Average Annual Production of Manganese Ore, 1934–38

	Long tons.
Russia	2,552,820
British India	776,151
Gold Coast...	411,621
South Africa	313,566
Cuba	146,822
Brazil	138,051
Egypt (Sinai)	110,756
Other countries (thirty-two) ...	399,693
	4,849,480

At least 90 per cent. of the world's manganese ore output is consumed in the iron and steel industry, mainly in the production of ferro-manganese, an alloy containing some 80 per cent. of manganese that is added to the molten steel in order to remove certain impurities that would otherwise impair the properties of the finished product. This is the chief use of manganese in the iron and steel industry, though the manganese that remains in the finished steel itself affects favourably the quality of the steel, and though some ore is used in the manufacture of manganese steel, and some is added to the blast-furnace burden in some cases. It is important to emphasise that no commercially usable substitute has been found for manganese ore in the iron and steel industry, although many possibilities have been tested. Hence the successful manufacture of steel by any country is dependent upon an adequate supply of manganese ore, or of ferro-manganese (or spiegeleisen) manufactured therefrom.

To understand what happens to the manganese ore output of the world it is important, therefore, to know the chief steel-producing countries of the world. The most active recent pre-war year in the iron and steel industry was 1937. I give below, therefore, the world's output of steel ingots and castings in 1937, showing separately in descending order of magnitude those countries that produced over 2,000,000 tons of steel.

World's Output in 1937 *of Steel Ingots and Castings*

	Long tons.
United States	50,568,701
Germany	19,050,372
Russia	17,149,000
United Kingdom	12,984,000
France	7,794,997
Japan (with Korea)	5,719,488
Belgium	3,801,586
Luxemburg	2,470,588
Czechoslovakia	2,254,879
Italy	2,065,582
Other countries (fourteen) ...	8,440,807
	132,300,000

In my paper I have given the world's exports and imports of manganese ore for the same five years, 1934–38. The means of these figures are summarised below :—

World's Average Annual Exports and Imports of Manganese Ore, 1934–38 (*Long Tons*)

Exports.		Imports.	
Russia	665,218	United States ...	611,910
British India ...	645,987	France	430,668
Gold Coast ...	400,194	Germany	359,942
South Africa ...	227,721	United Kingdom	229,170
Brazil	120,742	Belgium Luxemburg E.U. ...	223,734
Egypt	29,369	Japan	184,786
Cuba	100,000	Norway	107,906
Malaya	78,991	Italy	67,902
Other countries (twenty-seven)	117,938	Other countries (nineteen) ...	188,566
	2,386,160		2,404,584

The purpose of this Conference is to discuss mineral resources in connection with the promises held out by Mr. Roosevelt and Mr. Churchill in the Fourth Clause of the Atlantic Charter.

The statistical data summarised in the tables accompanying this paper, showing the figures of production, exports, and imports of manganese ore by, from, and to the various countries of the world, show that under the system prevailing prior to the war there was a continuous flow of manganese ore from the producing to the smelting countries, free of all hindrance, except where import duties had been imposed in order to bolster up a domestic industry, as in the United States, or where the fiscal system had been tampered with, as in Germany.

Looking at the problem as a whole, it seems quite clear from the foregoing analysis of results that pre-war arrangements were in every way adequate to enable every country fitted by Nature for the production of iron and steel to obtain by honest trading and purchase at fair rates in the world's markets the supplies of manganese ore needed. If therefore after the war international trading can be re-established on a free basis, it is quite clear that no special arrangement will be needed for manganese ore. I anticipate that a statistical analysis of other minerals on the basis of pre-war statistics will lead to a similar conclusion.

There is, however, one aspect of this subject in which some curtailment of pre-war freedom of flow of minerals will be absolutely necessary, namely, the prevention, at least for a period —say, at least one generation—of the free passage of minerals and other raw materials of use for armaments to the Axis countries in excess of their requirements for peaceful industrial purposes ; in fact, it will be necessary to provide for the rationing of these countries in minerals for a generation or more. For, as Sir Thomas Holland has shown on more than one occasion, the distribution of minerals in the world is such that if the British Commonwealth, the United States, and Russia so decide they can control the armaments manufacture of possible belligerent countries so as to make it impossible for them ever to go to war again.

Nickel, by Hon. Colin A. Campbell, M.L.A.

It is most appropriate that nickel should be included in this discussion of world resources. Almost a rarity 100 years ago, it is now one of the most essential metals for the maintenance of the standard of living at the level now considered necessary in the more advanced countries. Yet at the present time all the nickel used comes from three or four places in the world, and 85 per cent. of it is obtained from one small area in Canada. Coming largely from one country and needed by many, nickel forms a useful example of the post-war problem of distribution. This problem in the case of nickel was, indeed, successfully solved in pre-war years. For a long time nickel has been available to all countries in sufficient quantities to meet all needs at a price, which, not being subject to speculation, has remained practically unchanged for many years at a level which has yielded a satisfactory return to the producers and yet has not prevented the metal being readily obtainable for all purposes for which it was needed.

It is clear that the nickel required by the post-war world will still largely come from Canada. In fact, I would hazard a guess that 80 per cent. will come from Canada during our lifetime. This occurrence throws a particular responsibility on the British Empire, in that it will be its duty to see that it is available fairly to all desiring to use it for legitimate purposes, and yet to prevent its accumulation for war purposes. Post-war prospecting may, of course, disclose valuable new deposits, but there is at present no reason to anticipate that areas comparable with the Sudbury Basin will be uncovered.

On the other hand, there seems little doubt that the demand for nickel will be at least as great after the war as it was in pre-war days. Efforts to reduce the nickel content of some steels and other alloys have been made in past years, and are being intensified at present. It appears, however, that nickel will always be required for the higher grade steels and alloys. If, as must be the case, industrial development continues in America, in Great Britain, in Russia, and the various European countries, they will each require increasing quantities of nickel for those uses which have already been described, and for others which certainly will be developed. Engineers will continue to demand materials capable of withstanding more and more severe conditions and are likely to turn to nickel alloys to support their requirements.

Then, we must anticipate the development of a higher standard of living throughout the whole of the Far East, and when an increased use of aeroplane, automobile, and rail transport, of electric light and of all the other similar amenities which are involved in such a higher standard are required by the millions of India and China, nickel will be needed for these areas to perhaps an even greater extent than it is to-day in Western countries.

Unfortunately, perhaps, nickel, due to the strength, resistance to shock, wear, and corrosion which it confers on its alloys, is also a vital war material, and care is therefore necessary to see that in providing nickel for essential peace-time applications, it is not utilised by nations with aggressive intent to build up armaments. For this reason, too, since the United Nations will have obligations to maintain peace, sufficient nickel will need to be reserved to them for the provision of the necessary weapons required for the purpose of winning the peace.

Tungsten, by J. L. F. Vogel

Up to the date of the 1914 war, Germany had a stranglehold on the tungsten industry, and British steel makers imported all their requirements in the form of 96–98 per cent. tungsten metal powder. War conditions entailed production in England and several factories were started, including one owned by some thirty high-speed steel makers collectively, and the output of this factory alone reached 80,000 lb. a week of 98–99 per cent. tungsten by the end of the war.

The best quality high-speed steel contains some 18 per cent. tungsten, together with some chromium and vanadium. This is more or less a standard quality. Still better results are obtained by adding, in addition, cobalt and molybdenum. With such steels, modified in accord with steel makers' experience, high rates of cutting and deep cuts which bring the tool tip to a visible red heat can be employed, as tungsten steel has the property of maintaining its hardness at high temperatures. It has been known for many years that part of the tungsten can be replaced by molybdenum with more or less equal results, and use is being made of this in view of the present shortage of tungsten. A further advance has been made in utilising tungsten carbide containing about 6 per cent. carbon and cobalt.

The process of manufacture can be divided into two distinct parts. For producing tungsten metal powder and tungsten carbide it is necessary to separate the tungsten trioxide in the minerals from all other ingredients. The extent to which the tungsten trioxide must be refined differs according to the use to which it is to be put. For inclusion in molten high-speed steel, a product of 98–99 per cent. purity suffices, provided certain deleterious impurities are kept below definite limits.

For carbides and for tungsten filaments and rods, the oxide must be of the highest purity with an assay of over 99·9 per cent. tungsten trioxide. To attain this end the mineral must be treated chemically either by attack by soda or by strong acid. The various steps in the processes must be carried out with great care to ensure the requisite purity of the products and to minimise the loss of tungsten in the operations.

The second method of obtaining tungsten in a form capable of being incorporated in molten steel is by reducing the tungsten trioxide in the mineral either by carbon in electric furnaces or by aluminothermic methods in admixture with sufficient iron to yield ferro-tungsten containing 80–85 per cent. tungsten. In this case the mineral employed must be within a certain standard of purity, especially in respect of other metals, such as tin and copper, sulphur, phosphorus, and arsenic. In electric furnace production tin can be boiled off substantially,

but in using aluminothermic reduction this metal must be present only to a very small extent.

Turning now to the origin and production of the ores of tungsten, there are two distinct classes. The most plentiful by far is known by the name of wolfram and consists of tunstates of iron and manganese in varying proportions. Academically, distinction is made between ores high in iron and those high in manganese. The former are known as ferberites and the latter as hubnerites, but, commercially, both subdivisions are included together as wolfram. The second class is scheelite, a tungstate of lime.

Some forty-five to fifty years ago the chief sources of supply of the minerals were Portugal and Spain, Cornwall, Australia, and Bolivia. As the demand grew fresh discoveries were made, and from about 1905 Burma became a producer, and by 1914 it was giving the largest output. The war then increased the demand enormously, and widespread search for new deposits followed. It was not long before China came into the picture and very soon dominated production, although the U.S.A. began to obtain substantial output, though at high cost. Bolivia, Malaya, New Zealand, Nigeria also developed known and new deposits. The intensive demand was met to the best advantage from alluvial deposits, of which China especially had very large areas.

A feature of wolfram lode mining is the patchy nature of the deposits. Well-defined lodes have zones carrying good values, and then completely barren quartz may extend for a considerable distance. The nature of the lode mines of wolfram is such that no reputable mining engineer can, or will, estimate the yield over any extended length or depth, and bulk sampling alone is a true guide. In respect of alluvial deposits, drilling and then close pitting will give fairly accurate data and will enable work to be planned ahead.

All tungsten ores are extremely heavy, and their separation from gangue by water is efficient, but not from tin ore, the weight of which approximates to that of wolfram. However, separation of these two minerals can be effected by magnetic machines, as wolfram is feebly magnetic, while tin ore and gangue are not. Concentrates obtained in this way assay from 65 to 70 per cent. tungsten trioxide, or, in round figures, 2 tons of concentrates will yield 1 ton of tungsten.

In conclusion, I would point out that while the output of tungsten ores at the maximum of some 30,000 tons a year is insignificant in comparison with that of copper, tin, zinc, and other metals, every ton of tungsten is equivalent to 5 to 25 tons of steel in one shape or another, the whole of which is essential not only for our war effort, but for all means of rapid transport and modern engineering in time of peace. Its application and use is no bad example of the contribution of scientific metallurgy to the engineering industry.

The afternoon session was concluded by a paper on Aluminium, by Mr. M. P. Fogarty, which is too long for inclusion he e in full and of which an abstract would be unsatisfactory. It dealt fully with outputs, uses, financial policy, technical production, markets, &c.

R.A.F. Activity During July

Metropolitan squadrons of the Royal Air Force carried out one of their heaviest months' work during July. Offensive fighter operations ranged, by day and night, from Holland to Ushant; and Bomber Command carried a total load which almost equalled its previous highest for any month. Despite generally unfavourable weather for the time of year, on only four 24-hour periods during the month were there no main air operations by the R.A.F. in Britain.

A notable feature of the British attacks was the number made on Germany in daylight, as well as German-occupied Europe. In one of these, made by American-built Bostons on July 4th, air crews of the American Army Air Forces took part for the first time in this war in R.A.F. bombing operations. This was on enemy airfields in Holland. Two of the six U.S.-manned aircraft did not return from this attack. Starting with a raid by a comparatively small force on German shipyards at Flensburg near the Danish border on July 2nd, daylight attacks were made on a series of targets exceeding in number those attacked by night. Flensburg received two more visits (July 11th and 16th), Danzig one (11th), and Lubeck one (16th). The Ruhr and N.W. Germany were attacked seven times by aircraft flying singly (16th, 17th, 18th, 20th, 21st, 27th, and 28th), and single aircraft also went by day to Mannheim and Frankfurt on July 25th. In addition, various airfields, power stations, railways, chemical works, and other targets were bombed by day at Abbeville, Boulogne, Mazingarbe, Ghent, and Sluiskil.

Rather fewer, but heavier attacks on Germany were also made by Britain's night bombers. Principal targets were found at Bremen (July 2nd–3rd); Wilhelmshaven (8th–9th); the Ruhr (13th–14th, 21st–22nd, 23rd–24th, and 25th–26th); with specially heavy assaults on the great inland port of Duisburg on 21st–22nd and 25th–26th; Hamburg on 26th–27th and again on 28th–29th; on Saarbrucken on July 29th–30th, and on Dusseldorf on July 31st–August 1st. On several occasions, whilst these night raids were proceeding, bombing attacks were also made on enemy aerodromes in the Low Countries from which Nazi night fighters operate. On two nights alone—Duisburg on 25th–26th and Hamburg on 26th–27th—around 1200 tons of bombs were dropped in the target area. That weight of bombs considerably exceeds anything achieved by the Germans at the height of their bombing against Britain over a year ago. Besides bombing, mines were laid in enemy waters on several nights. Bomber Command lost 184 aircraft in all these operations up to the night of July 31st–August 1st. Nine enemy fighters were destroyed by R.A.F. bombers.

Fighter Command's operations, apart from sweeps, were mainly attacks against the transportation systems operating for the Germans in and around N.W. France. Goods trains, locomotives, barges, and coastwise shipping were shot up with cannon-armed fighters or attacked by fighter bombers. Comparatively new features of this fighter offensive were the attacks on railway engines, whose boilers have been exploded by cannon fire, and the extensive raids made by fighters operating at night. Altogether, Fighter Command lost 62 aircraft, destroying 32 German fighters and 10 bombers.

Enemy bombing raids on Britain during July showed some increase in scale, rather than in frequency. Actually, there were no more raid-free nights in the first half of the month (seven) than in the second half. But this increased weight of enemy counter-attack was never, either in numbers or concentration, at all comparable with the British effort. It is of interest to note that whereas in the first half of July enemy raids were widely spread around the coastal districts only, from the North-East to South Wales, after the big attack on the Ruhr and Duisburg they sent their night bombers inland. Their month's raids cost the Germans altogether 52 bombers and two fighters.

American Engineering News

Coal Developments in the United States

With war requirements for immediate increase in power production, coal is returning to a more favourable position than it has had for some years, since a powerful steam plant can be built and completed in a year—or even less—while a hydro-electric plant requires usually three or four years, and often more. At present about 70 per cent. of the electric power used in industrial and manufacturing plants is generated by coal-fired boilers, and this proportion is increasing. With severe restrictions on the use of oil, this fuel is not available for general power production. And in many cases, of course, steam production of electricity is cheaper than hydro-electric production. Furthermore, there are enormous resources of coal, and modern methods and equipment for mining, raising and treating coal provide for rapid expansion of output. Labour difficulties have been serious, as in other important lines of industry, but these may be expected to decrease as the vital needs of supplying and serving the fighting forces are recognised. In 1941, the production of bituminous coal was about 500 million tons, and that of anthracite 54 million tons. In the anthracite field an important problem is the drainage of mines to reduce the high cost of pumping and the loss of workings by flooding, and to facilitate exploration and extension developments. Use of larger mine cars expedites movement from the working faces to the shaft or surface, and 10-ton automatic dump cars are employed in shuttle service in some mines. Welded steel cars are in experimental use, as having a longer life than riveted cars. Ventilation methods and equipment are also being improved, and in combination with dust-control methods have led to a decrease in explosions. Other lines of development are in the more effective and economical uses of coal, and the cleaning and blending of coals to meet particular conditions, together with increased recovery of by-products.

American Multi-wheel Locomotives

Locomotive practice in the United States is continually producing something new, and one of the latest novelties is the articulated four-cylinder 2–6–6–6 engine, of which several have been built for the Chesapeake and Ohio Railway, to supplement an earlier 2–10–4 design. The new engines are designed for a sustained speed of 35 to 40 miles an hour with heavy freight trains on severe gradients in the Alleghany mountains. The peculiarity is in the use of two independent groups of six driving wheels, and a six-wheel trailing bogie under the fire-box. The drivers average nearly 20 tons per axle. Tractive force is 110,000 lb., and there is no booster engine on the trailing bogie. The boiler, with three thermic siphons, is 46ft. long overall. Valve gear of the Baker type operates 12in. piston valves. Cast steel engine beds, duplicates for the two groups of drivers, include the cylinders, back cylinder heads and various attachments. They are connected by an articulated hinge joint, a tongue or lug on the forward frame engaging a pocket on the rear frame and being locked by a hinge pin. Fuel consists of bituminous coal. The huge tender is peculiar in having a six-wheel bogie under the forward end and an eight-wheel bogie under the rear end.

Cylinders, four	22½in. by 33in.
Driving wheels, diameter	5ft. 7in.
Bogie wheels: Leading	3ft.
Trailing	3ft. and 3ft. 7in.
Wheel base: Driving	34ft. 8in.
Rigid	12ft.
Engine	62ft. 6in.
Engine and tender	112ft.
Weight on drivers	235 tons
leading bogie	32 tons
trailing bogie	95 tons
Weight of engine	362 tons
tender	215 tons
Boiler, diameter	8ft. 2in. to 9ft.
Fire-box	15ft. by 9ft.
Combustion chamber, length	9ft. 10in.
Tubes, length	23ft.
Boiler pressure	260 lb.
Grate area	135 sq. feet
Heating surface:	
Fire-box, chamber and siphons	762 sq. feet
Tubes and flues	6478 sq. feet
Total	7240 sq. feet
Superheating surface	3186 sq. feet
Tender: Water	25,000 gallons
Coal	25 tons

Feldspar as a Fire Extinguisher. — An American chemist attached to the U.S. Geological Survey has established the fact that finely ground feldspar, a constituent of a large variety of common rocks, is a cheap and easily obtainable material effective against incendiary bombs. Tests have shown that when a magnesium bomb was ignited and placed on a pine board or floor and covered with ground feldspar, the fire was extinguished so quickly that the wood was charred only to the depth of ¼in. In order to protect the public interest, the Department will obtain a Government patent for the process and will make the process available to commercial concerns.

The Engineer

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Contents

THE ENGINEER, August 7th, 1942. PAGE

A SEVEN-DAY JOURNAL 105

LEADING ARTICLES—
SCIENCE AND CULTURE 114
DIVING AIRCRAFT 114

SPECIAL ARTICLES—
EXCAVATING MACHINERY IN THE IRONSTONE FIELDS. No. I. (Illus.) 108
MODEL QUALITY CONTROL CHARTS. No. III. (Illus.) 106
SAFETY FACTOR OF WINDING ROPES IN DEEP SHAFTS 119
SUPERVISORY REMOTE CONTROL FOR WELLINGTON, NEW ZEALAND. (Illus.) 116

AMERICAN COPPER MINE AND REDUCTION WORKS. No. III 120
BRITISH ASSOCIATION. No. II 111
PROTECTIVE COATINGS FOR STEEL 122
R.A.F. ACTIVITY DURING JULY 113
ROYAL ORDNANCE FACTORIES. No. II 121

LETTERS TO THE EDITOR—
LATIN AND ENGINES 115
FRENCH LOCOMOTIVE PERFORMANCE 115

OBITUARY—
ALFRED W. MARSHALL 115

NEWS AND NOTES—
AMERICAN ENGINEERING NEWS 113
FORTHCOMING ENGAGEMENTS 124
MARKETS, NOTES AND NEWS 123
NOTES AND MEMORANDA 124
SIXTY YEARS AGO 116

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The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper or described in its editorial columns should not be taken as an indication that they are necessarily available for export.

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CHANGES OF ADDRESS

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SCIENCE AND CULTURE

THE Herbert Spencer Lecture delivered by Professor A. G. Tansley in Oxford in June has now been published by George Allen and Unwin, Ltd. It merits the careful attention of all those who take a philosophical interest in the immediate future of mankind, and the approach towards a higher level of civilisation. Professor Tansley's theme is that unless the spirit of science permeates all people, and particularly their leaders, progressive improvement will remain unattainable. He does not mean science in any narrow or prescribed sense, but rather a "method of thought" which can be applied as well to social, ethical, and even spiritual subjects as to the examination of the physical universe. He notes and discusses the causes which make science antipathetic to many people, and concludes that to remove this prejudice introduction to scientific principles must take place at an early stage of education. Let us repeat that he does not invite the pursuit of a particular science, but the inculcation of the "scientific habit of mind," which insists on preliminary, careful, and accurate survey of facts and constant testing of theory by fresh observations and experiments.

It would be of interest to survey many of the arguments which Professor Tansley advances, but since they seem to us all to lead to a single result, we propose only to glance at his finale and conclusion. It may be expressed broadly as a conviction that science, far from being inimical to culture, must be regarded as essential to it. "I contend," he writes, "that education cannot justly be called liberal to-day unless it includes an introduction to science and the history of science, simply because science is a vital part of the culture fitted to the contemporary world." Once more he insists that he does not seek for specialisation, which he rightly points out may have a narrowing effect upon the mind; it is the "habit of dispassionate objective investigation and of respect for objective truth" that he desires to see fostered at an early age, "in the secondary, if not in the elementary school." His contention that science has a cultural value will be contested by those who have been bred up in the belief that only classical subjects and the "humanities" are fitted to improve the mind of man. For hundreds of years that was essentially true. Science impinged too little on human affairs to make the study of it a necessary part of a cultured education. But even through part of that long period dilettante science was recognised as a desirable accomplishment for refined people. The use of the globes was taught in schools and the fashionable world attended lectures on anatomy—with an actual cadaver open before them—or the addresses of Tyndal, Huxley, and Faraday and their predecessors. Thus through a long period there has been a glimmering of the fact that science has cultural value. To-day, when science—we use the word in its broadest sense—enters into everything it is more important than ever before that the world should hold a sympathetic attitude towards it and should recognise that not only has the scientific method cultural values but that the affairs of the world can no longer be conducted without its help.

A good many years ago a sharp distinction was made in schools by dividing them into classical and modern sides. It fostered regrettable prejudices. The classical side contemned the modern, and the modern put itself in a false position by the purely utilitarian standpoint it adopted. It did not regard scientific education as a means of improving the mind—the business of education—but solely as a preparation for making an income. Science, moreover, was outside the pale of the professions—law, medicine, the Army and the Church—it was concerned with trade and was therefore "low." But we have advanced beyond that stage. We are approaching, slowly perhaps, yet inevitably, the time when classical education—not necessarily ancient classics—will exist side by side with scientific education, and when, in Professor Tansley's words, scientific culture will "take its place on equal terms beside the literary and artistic cultures."

Diving Aircraft

THE merits of bombing on the dive are still a matter of the keenest controversy. Much argument is expended on the question how far we should or should not use such methods ourselves. In the campaign in North Africa we have, through the eyes of our Press observers, seen the dive-bomber attain some of its best results and some of its most dismal failures. As engineers, we conclude that the tool is potentially good, but calls in use for very skilful handling. Whether in consequence it is a good weapon for use in war depends on a balance of factors only rightly to be weighed by the men on the spot. In the daily Press some writers go so far as to suggest that we effectively have this weapon already in our fighter-bombers once we care to use them in that fashion, forgetting—or not knowing—that such fighter aircraft when in a long dive are like a brakeless bicycle on a long steep hill. In such conditions dangerous speeds are soon reached. No aircraft used for prolonged dives can be safe without the provision of adequate air brakes. Without them, full level speed is attained by a fighter, even without engine power, on a downward slope of as little as 10 deg.; at 20 deg. the speed approaches the safety limit, whilst in the true long dive at 45 deg., or more, structural failure is a serious risk, with or without the loss of control due to aerodynamic instability. In brief, the two types are not interchangeable.

If dive-bombing is to be accurate, it calls for as close an approach to the target as can safely be made, having regard not alone to enemy attack by A.A. gunfire, but to the need for vertical room in which to pull out of the dive without, in Air Force parlance, "hitting the deck." Because of the ill-effect on the pilot of any radial acceleration above 5 *g*, there is a definite limit to the rapidity with which the pull-out can be effected. Hence he must have air room. These are the main reasons why it is essential to fit air brakes to such craft, and only those so fitted can be rightly termed dive-bombers. The air brakes fitted to German types limit the speed to some 250 miles an hour, which enables them, so far as aerodynamic limitations are concerned, to approach within 1000ft. of the target. It is true that this low speed of flight makes them an easy prey to hostile fighter aircraft which chance to be in their neighbourhood, but as the war on land has shown it happens not seldom that at the critical moment when the dive-bomber is sent into action, the fighters are otherwise or otherwhere engaged. In actions over the sea their power is less liable to fighter interception, but they still have to face heavy A.A. gunfire, which in the case of an attack on naval vessels is sure to be manifold and accurate. In such a contest the dive-bomber is very vulnerable; it affords a non-deflection target during its final dive, and even the slightest structural damage it may receive is likely to upset its controls so as to make recovery impossible before hitting the sea.

Efficiency in such bombing attacks can only be expected when large numbers are employed, so large that the A.A. guns have not time to fire at more than a few of their assailants in the very few seconds available. In such cases some will survive to push home the attack, and the likelihood of a target ship, especially a large one, being struck is very great—perhaps five times as likely as if the attack were made from a high level. On the other hand, the striking velocity of the projectile is but half what it would have been had the bombs been dropped from altitude, and the damage resulting from a hit will be so much the less. In fact, penetration of an armoured deck will not be attained unless the bombs are released from the greatest height attainable, and is doubtful even then—depending on the type of ship. A bomb which just fails to hit the target may, however, be very dangerous, for a "near miss" bomb which detonates on the sea alongside may hole the plating of the ship, and this is as likely to happen from a bomb dropped during a low dive as from one released from a high altitude.

It is sometimes claimed that the awe-inspiring noise made by a diving aircraft during its final rush at the target greatly increases the effectiveness of its attack. This may be so in land warfare when the target chances to be troops caught in the open or otherwise unprotected. But what would add most of all to its effectiveness as a weapon of land warfare would be the addition of a high-velocity anti-tank gun. It may be granted at once that such an aircraft would have to be especially designed to take the gun. But on the day when it is so equipped, diving aircraft will have acquired a new potency and a definite, perhaps final, challenge will have been thrown down to the tank.

Obituary

ALFRED W. MARSHALL

MR. ALFRED W. MARSHALL, whose lamented death at the age of seventy-seven years took place in a Croydon nursing home on July 21st, following a long illness, was an outstanding figure in model engineering, but was also interested in all phases of engineering work. He came of an old Scottish family, and was born in London. He was apprenticed to David Napier and Sons, of Lambeth, and was an "improver" with Maudslay, Sons and Field. He then entered the drawing-office of Nalder Brothers, electrical instrument manufacturers, and afterwards was for some time in the electrical department of Doulton's of Lambeth. He studied at evening classes at the Finsbury Technical College, the Birkbeck Institute, and the Central Institution at South Kensington. For some time he was lecturer to the engineering students at Woolwich Polytechnic.

Marshall was always interested in electrical work, and he achieved the distinction of Silver Medallist in Electrical Instrument Making at the technological examinations of the City and Guilds Institute. He was a pioneer in this country in the design and making of small electric motors, and was engaged in this work on his own account until his business was acquired by the Crypto Works, Ltd., with whom he afterwards became associated as technical designer and adviser. For some years he practised as a consultant, but he gradually became absorbed in the editorial activities of *The Model Engineer*, to which, until he retired to his home at Chipstead, he devoted most of his time and his energies. He was a valued member of the Institution of Mechanical Engineers, an associate member of the Institution of Electrical Engineers, a life-long member of the Junior Institution of Engineers, and a founder member, and later the President, of the Society of Model and Experimental Engineers. He acted as consulting engineer to the series of *Model Engineer* Exhibitions, and for many years was the senior judge of the models entered for the competition section. Throughout his life he took the keenest interest in experimental work, and was associated with Sir Hiram Maxim's investigation at Norwood. Among his early personal friends he counted the late Sir Alfred Yarrow and Lord Kelvin. His home was never without a workshop, in which he tried out his designs and carried out many constructive experiments. Much of his personal experience was embodied in the articles he wrote in *The Model Engineer* and in the several "M.E. Handbooks" of which he was the author.

Wherever mechanical engineers foregathered, there Mr. A. W. Marshall was to be seen. Essentially a practical man himself—he loved to use his hands—he took the keenest interest in mechanical devices and workshop methods. Hence he was not only an admirable and sympathetic listener, always ready with praise, but was ready to draw from a long experience for the benefit of others. No one can hope to estimate the valuable service he paid to that most delightful and profitable recreation, model-making, and many an engineer, old and young, who is blessed with a workshop will regret the passing of a good friend and wise counsellor.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LATIN AND ENGINES

SIR,—The President of the Board of Education is reported to have made the following remarks in an address to the boys of Malvern College: "I have had it put to me that we should abolish Latin and introduce a compulsory study of the internal combustion engine instead. My answer to that is that if you have had a proper education in Latin you can—so to speak—take the internal combustion engine in your stride."

This pronouncement seems to me to throw a flood of light upon the very roots of many of our wartime troubles and inefficiencies. It encourages the schools to go on turning out crowds of youths with a smattering of Greek and Latin, together with a few real scholars fit for the Church or the Law, while ignoring the foundations of science, without which young men find themselves handicapped during their three years or so in a technical college, followed by practical apprenticeship.

What is even worse is that it seems to lend support to the idea that Government Departments can be staffed with young men having no technical training or practical experience, but filled with dead languages and pride. These men do not aspire to design or manufacture internal combustion engines or anything else, because they are fully aware that they could not do it. But they do consider that they are competent to overrule the experienced and able men who do the work and who have to be contented with smaller salaries and subordinate positions.

It is high time for the engineers of this country—I am not referring to fitters and turners, who are well looked after—to give a little attention to their own interests.

July 31st. MCANDREW.

FRENCH LOCOMOTIVE PERFORMANCE

SIR,—The three letters on the above subject in your issue of July 24th show the interest that is taken in it, and as these have partly been prompted by the letter appearing in your issue of July 10th and all refer to it, the writer would like to comment on the remarks.

Mr. Keiller's statement that indicator diagrams show no fall off in tractive effort up to 65 m.p.h. with the P.O.-Midi 4–8–0, when working at a very early cut-off, is accepted as correct. The argument is advanced that, therefore with a single expansion locomotive working at an early cut-off, there should be no fall off in pull with increasing speed, and on the evidence put forward the argument is perfectly reasonable.

Counter-pressure tests made by the writer on single-expansion locomotives fitted with similar spring-closed poppet valves show that when tested at 15 per cent. cut-off there is practically no fall in draw-bar pull with increasing speed up to 60 m.p.h., but there is a drop of over 40 per cent. at 70 m.p.h. In later cut-off positions there is a progressive fall with increasing speeds similar to that with piston valves which also fall progressively with increasing speed at 15 per cent. cut-off.

The reason for this apparent inconsistency at an early cut-off is due to the lag of the spring in closing the valve. At slow speeds there is practically no lag, but as the speed increases the lag increases, so it is equivalent to automatically increasing the cut-off as the speed increases. With a very early cut-off the valve is open during a small crank angle, so the extra angle due to spring lag is an appreciable proportion of the total and its effect is apparent at the draw-bar up to a speed of 60 m.p.h., but at higher speeds other valve conditions start to have an effect. In the lower cut-off positions the increase due to spring lag becomes such a small proportion of the total that its effect is no longer apparent.

It is noted that Mr. Nock considers the writer has made statements wide of the mark. He refers to a run made with a "Pacific" locomotive in 1936, stating that 25 per cent. of the normal tractive effort was obtained at 18 per cent. cut-off at a speed of 78 m.p.h. No doubt these figures have been given in good faith, but they are incorrect, and the writer from his personal knowledge of what actually occurred must correct them.

The best draw-bar horsepower recorded, with allowance for gradient, was 1410 at a speed of 80 m.p.h. and not 1880, corresponding to a pull of 2·95 tons on the level and not 4·1. The speed fell 10 m.p.h. on the 5-mile gradient, so a reduction should be made for retardation reducing the pull to 2·6 tons, equivalent to 16½ per cent. of the normal tractive effort.

It should be made clear that this test was to find the power required to run the train at the accelerated timing and was not a test to find out the performance of the locomotive at a definitive cut-off; such tests are not made in this manner. The cut-off position was between the 15 and 25 per cent. graduations. Those readers with footplate experience know that the distance between these graduations is usually less than three-quarters of an inch, but probably few of them will realise that moving from 15 to 25 can double the draw-bar pull; for that reason no tests to obtain performance curves are reliable, unless the graduated plates have been specially checked immediately beforehand, as they may be out of adjustment and the above remarks will make it clear that only a slight amount will have a large effect. For this reason

the cut-off figures given in the table are not reliable enough for a discussion of this nature.

Large errors can occur in draw-bar horse-power figures calculated from a train resistance formula. This is no reflection on the formula; it gives a guide to what may have to be allowed for. Only those who have seen plotted observations of train resistance realise their wide divergence, even when the experiments are made with the greatest care.

It would take up too much of your space to describe all the precautions taken during counter-pressure tests to ensure accuracy. They are made on a long section of level track, and those who are interested are referred to a brief description in your issue of August 5th, 1938.

The writer has the same regard for single-expansion locomotives as Mr. Parker and has no wish to be unduly critical of British examples. They are free from complication and reliable, and the way they stand up to rough usage and small attention, and still work, is very creditable. At the same time, if we are frank with ourselves, we must admit a good deal of insular self-satisfaction. The writer drew attention to the wonderful results obtained from these French compounds at high speeds in economical cut-off positions, in the hope that some British engineer would do as much for the single-expansion locomotive as Monsieur Chapelon has done for the compound.

He hopes that he has proved that the solution is an improved steam distribution at an early cut-off; a wide port opening and small clearance volume are not impossible if we are prepared to think along new lines. Is it beyond the skill of British engineers to design a robust and reliable valve gear fulfilling the requirements stated towards the end of the writer's letter of July 10th? He thinks otherwise, and hopes that the far-reaching effects of the improvement are fully understood.

T. Robson.

Darlington, July 29th.

Sixty Years Ago

Railway Activity

The year 1881 was one of very great activity in the building of railways in the United States. According to a note in our issue of August 11th, 1882, the previous year had witnessed the construction of 9358 miles of railway. The greatest mileage previously completed in a year was 7379 miles in 1871. The 1881 figure at 25,000 dollars per mile represented an expenditure of 233,750,000 dollars. In addition, at least 75,000,000 dollars had been spent on lines in progress and 100,000,000 dollars on the improvement of old lines, building new stations, and adding to equipment. The total expenditure thus amounted to over 400,000,000 dollars. It seemed probable, our note added, that the new mileage to be opened in 1882 would equal that of 1881. Up to June 1st, 3677 miles of line had been opened and by the end of the year it was anticipated that the total additions would be not far short of 10,000 miles. . . . In our own country, according to another note in the same issue, the activity which had prevailed among locomotive builders for the past year was continuing. The factories were filled with orders for all sorts and sizes of engines for Indian, Colonial, and foreign railways, as well as for home lines. It was difficult to make contracts for delivery before the spring of the following year. The prosperity of the locomotive building industry was being shared by Continental engineers, and in America the demand was so great that prices had nearly doubled within the previous two years.

The Ministry of Supply (Iron and Steel Control) announces that Mr. Stephen Lloyd has become sole Director of Bolts, Nuts, and Rivets, as Mr. Richard Beesley has had to be released to return to his firm.

Supervisory Remote Control for Wellington, New Zealand

By E. M. S. McWHIRTER and H. J. WARD

ALL supervisory remote control systems have as their primary object the indication and control of switchgear and other plant used in the generation, transmission, and distribution of electricity, when situated at an unattended sub-station and controlled from an attended station some distance away. The main urge towards remote control is not entirely the economic one of saving man power at the sub-stations, because it is now realised that if the modern complicated inter-connected network for power distribution is to be properly controlled, then there must be a central control room where the engineers can be instantly aware of everything that is taking place all over the network in order that no action of theirs at one point shall have deleterious reactions at another.

With such basic considerations in mind, and having regard to the distances often existing between the control point and the sub-station, it was natural that communication engineers should have turned their thoughts towards helping the power engineer to achieve his object by using a limited number of pilot lines. Prior to the war of 1914–18, remote control equipments had been installed in various parts of the world by power engineers, for the most part utilising one wire per unit (controlled or indicated). The relays employed were usually those associated with switchgear design rather than the smaller and lighter current relay familiar in automatic telephone switching. Such equipments were necessarily expensive, and to a degree inflexible, inasmuch as when all the pilot wires originally provided had been used, a further extension of the system involved the major expense of laying another multicore cable.

Progress in the Use of Automatic Telephone Apparatus

In the decade following the end of the last war, equipments were produced for the first time which enabled switchgear in remote sub-stations to be individually controlled over three or four telephone type pilot wires. Two such systems, designed by the Western Electric Company in the United States of America, had a comparatively wide application on the American Continent, and were manufactured by that company's London house for use in this country and throughout various parts of the British Empire.

Of these two systems, one employing three-line wires, and based on the selection principle of the train-despatching selector and selector key, was intended to control a number of sub-stations connected in tandem through one set of pilot wires. The other system, employing four-line wires, was based on the principle of two synchronously rotating distributors, one at each end of the pilot, and was primarily intended for the remote control of a single large sub-station. With the rapid growth of supervisory remote control, it was soon found that the selection limitations inherent in these two systems militated against the power engineer's desire to extend the centralisation of his control to the full. Moreover, power engineers were beginning to be familiar with and confident of the possibilities of automatic telephone switching equipment, and it was natural that later equipments should tend towards employing the relays and switches that had become standardised in the sphere of automatic telephony.

During the period 1930–39 Standard Telephones and Cables, Ltd., designed and installed many important supervisory remote control installations throughout the British Empire, and in these the progress in economy of apparatus and in the expansion of facilities offered has been continuously maintained, culminating in the equipments supplied to the City of Wellington during 1939 for the complete centralised control of its electricity undertaking. It is not possible in the present short article to trace in detail this progress in design, but it will be as well to state briefly the facilities provided by the earlier types of equipment and to compare them with those now available, and so successfully applied to Wellington.

The earliest equipments using three or four-line wires enabled switches to be controlled and indicated. Remote indication of meters, if provided at all, was given by using a pair of pilot wires for each meter. Indication of the position of a remote switch was provided by red and green lamps, although it was later found necessary to introduce a third white lamp in order that the control operator could quickly determine which switch had changed position. The controller's equipment, then, consisted originally of rows of keys with their associated red and green lamps. Although later designs employed control diagrams, the control keys with their associated three lamps required so much space that diagrams for large equipments began to assume unwieldy proportions.

The equipment in use at Wellington is described in more detail later, but mention of the following facilities will serve to emphasise the progress which has been made in the application of automatic telephone apparatus to remote control. A number of sub-stations are controlled and indicated over one pair of pilot wires, whilst metering facilities are provided over other pilot wires to the more important stations. Continuous proving of pilot lines, and indication of sub-station alarms and of remote control supervisory alarms are also included, whilst any switch control circuit can be remotely transferred to a routine test circuit, enabling the whole switch control and indication operation to be tested without disturbing the switchgear position. All these facilities are controlled and indicated from one central control desk, a single combined key and lamp replacing the earlier two control keys and three lamps per switch. The indications are duplicated on a wall diagram in order to present a complete up-to-the-minute picture of the city network to the control engineer, whilst the miniature line diagram on the desk with the control keys inset therein enables him to study the more important switchgear interconnections.

Progress in the design of supervisory control equipment and the flexibility of modern equipment is well exemplified when it is realised that the contract for the Wellington City Council electricity department was carried through all stages of design and manufacture in London by Messrs. Preece, Cardew and Rider, consulting engineers, and Standard Telephones and Cables, Ltd., by correspondence only with the Wellington City Council

engineers, and this despite the fact that the equipment had to operate switchgear already existing in Wellington and supplied by a number of different manufacturers and of a number of different types. That the equipment was so designed, manufactured, and shipped to site and installed by the electricity department's own engineers, with the co-operation of one Standard Telephones and Cables, Ltd., engineer from London fully emphasises this feature.

ELECTRICITY SUPPLY TO THE CITY OF WELLINGTON

Electrically, New Zealand, for her size and population, is among the best served countries in the world. Her water power has been developed during the last forty years by the public works department, and to-day hydro-electric stations feed the national networks which cover North Island and South Island alike.

The extent of the energy made available from the hydro-electric undertakings at Mangahao, Waikaremoana, and Arapuni is evidenced by the fact that, despite the use of electricity by farmer, manufacturer, and householder for every conceivable purpose, the steam plant of most of the cities of the Dominion is retained as stand-by equipment only, and Wellington is no exception to this rule. The capital city of the Dominion, it takes bulk power *viâ* the Government station at Khandallah from the hydro-electric station at Mangahao, supplementing this supply when necessary from the municipal generating station at Evans Bay.

Supply from these stations is taken to the main switching station at Jervois Quay, and from there a network of interconnected ring mains supplies power at 11 kV to twelve major sub-stations in the city area. From these major sub-stations are fed a number of minor sub-stations, from which power is distributed to the ultimate consumers. Certain of the major sub-stations also supply the city traction network through rotary converters at 550 volts D.C.

In planning the supervisory remote control system for their network, the city's engineers, with this grouping of sub-stations in mind, further classified the switchgear at the major sub-stations into three categories :—

Class (*a*)—Switchgear of primary importance to the 11-kV network, comprising generators, ring mains, bus-bar interconnectors, and the like.

Class (*b*)—Switchgear of minor importance to the 11-kV network.

Class (*c*)—Other switchgear.

It was decided that automatic mimic wall diagrams of the 11-kV and 550-V networks should be provided, whereon should be depicted in full the plant in the municipal generating station and the main switching station, such of the switchgear at the Government sub-station as concerned the city network, and the major sub-stations, together with their interconnections. In addition, the minor sub-stations were to be shown on these diagrams in their relative positions.

In depicting the three main stations and the twelve major sub-stations mentioned, the representation of Class (*a*) and Class (*b*) switchgear was to include automatic indication of the condition of these elements, whether closed or open, whilst the representation of the condition of Class (*c*) switchgear was to be effected manually on the diagram itself. As far as the minor sub-stations were concerned, an existing sub-station alarm system of Western Electric design, previously serving the major sub-stations and certain of the minor sub-stations, was to be diverted exclusively to serve these minor sub-stations.

A control desk was to be provided, including network diagrams similar to those mentioned above, but in skeleton form only. These diagrams were to include Class (*a*) switchgear and the system interconnections, together with such Class (*b*) switchgear as was necessary to make the diagram coherent. From this desk the control operator was to be given complete control facilities for his Class (*a*) switchgear. The representation of this gear on these diagrams was to be such as to enable him to initiate any required controls and to provide indication of the condition of the switchgear. The representation of the Class (*b*) switchgear was to be manual only, the position of the manual symbol giving the condition of the unit represented.

REMOTE SUPERVISORY CONTROL EQUIPMENT

The actual representation in the wall network diagrams of the Class (*a*) and Class (*b*) switchgear takes the form of magnetic semaphore indicators, each containing a lamp. The semaphore bars form part of the network diagram, and by their position relatively to the lines of the network indicate whether the switch units in question are open or closed, the lamp being automatically flashed to draw the control operator's attention to any change of position not originating from the control desk.

On the control desk Class (*a*) switchgear is represented by manual semaphore keys and Class (*b*) switchgear by manual semaphore symbols. The bars of these semaphore keys and symbols form part of the miniature network diagram, and by their position relative to it indicate whether the switchgear is closed or open. The semaphore keys enable the control operator to initiate the required controls, and each key contains a lamp. This lamp flashes automatically to call the control operator's attention to any change of condition not originated by himself and is further used as a pilot lamp when originating a control, being flashed rapidly to indicate that the circuit has been selected for control.

Class (*c*) switchgear is not included in the remote control system, and is represented on the wall diagrams only, where its representation takes the form of manual semaphore indicators pre-set by the control operator in accordance with the known condition of the switchgear. The minor sub-stations are represented on the wall diagram only, where for each there appears a single lamp which lights whenever a fault condition obtains at the sub-station. No indication, however, is given of the exact nature of such fault condition.

For the satisfactory operation of the system it is essential that the control operator should either be given continual information as to the loading of his network or that he should be able to obtain this information automatically when desired. His requirements do not fall entirely into either category, and certain information, therefore, is given continuously, while he may obtain other information by the operation of appropriate keys on the control desk. The automatic indications include :—

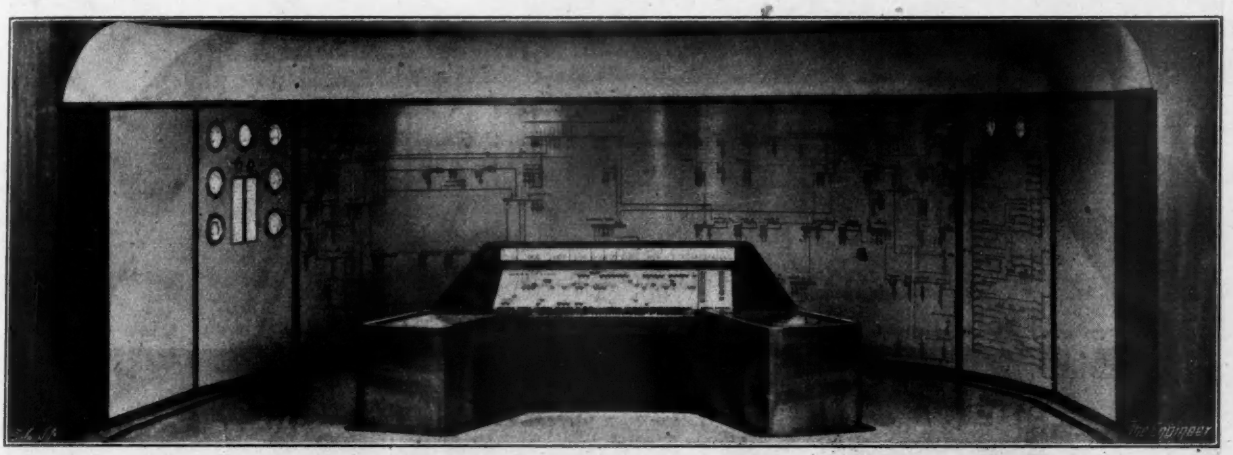
(*a*) The power intake from the Government station.
(*b*) The supply network voltage.
(*c*) The supply network frequency.
(*d*) The traction network voltage.

While the generating station at Evans Bay, permanently manned, naturally has indications (*b*) and (*c*) independently of the control operator, indication (*a*) is extended to them by the control operator for their information.

The indications which the control operator may obtain on request comprise :—

(*e*) The output from any one of four generators at Evans Bay.
(*f*) The voltage or current of any one of the four generators at Evans Bay.
(*g*) The current taken by any one of three rotary converters at the main switching station.

These indications are sufficient for the normal running of the system, but in an emergency the control operator is provided with the means of sectionalising his network rapidly



CONTROL ROOM

and of synchronising and paralleling the two supplies should they have been disconnected from one another.

For sectionalising the network the control operator is provided with five keys on his control desk by the use of which he may cause the network to be sectionalised in any one of the five ways. Signals initiated from these keys are effective at all stations simultaneously, at each of which up to five simultaneous controls can thereby be effected.

For synchronising and paralleling the two supplies, the control operator is provided with :—

(*h*) Indication of the voltage of the incoming supply.

(*i*) Indication of the voltage of the running supply.

(*j*) Indication of the relative phase and frequency of the two supplies.

(*k*) Means for paralleling the two supplies immediately he is satisfied as to the correct phase, frequency, and voltage relationships between them.

It is essential that in an emergency, contact shall not be lost between the control operator and the power station, and to this end normal telephonic intercommunication is supplemented by a series of routine instructions which the control operator may transmit *viâ* the supervisory gear to the generating station, where they are displayed visually on an indicator of the signal head type. Further, certain automatic indications of the condition of the steam and generating plants at the power station are automatically signalled to the control operator by the supervisory gear, so that he may know what machinery is immediately available, and what can shortly be brought into service. Another interesting feature of this system is that the Western Electric alarm system, previously mentioned, incorporated telephone facilities which have been included and extended in the supervisory control scheme.

Certain important new features have also been added. In order that a permanent record of any important conversation taking place between the control operator and the Public Works Department, power station, or any of the sub-stations on the network may be available for reference if necessary, a dictaphone recording system has been incorporated and may be brought into service at any moment by the depression of the key by the control operator. Further, to simplify his task in emergency, a loud-speaking telephone system has been added using voice-operated switching, which enables him to carry on conversation with the power station or the main switching station while carrying out controls from his desk.

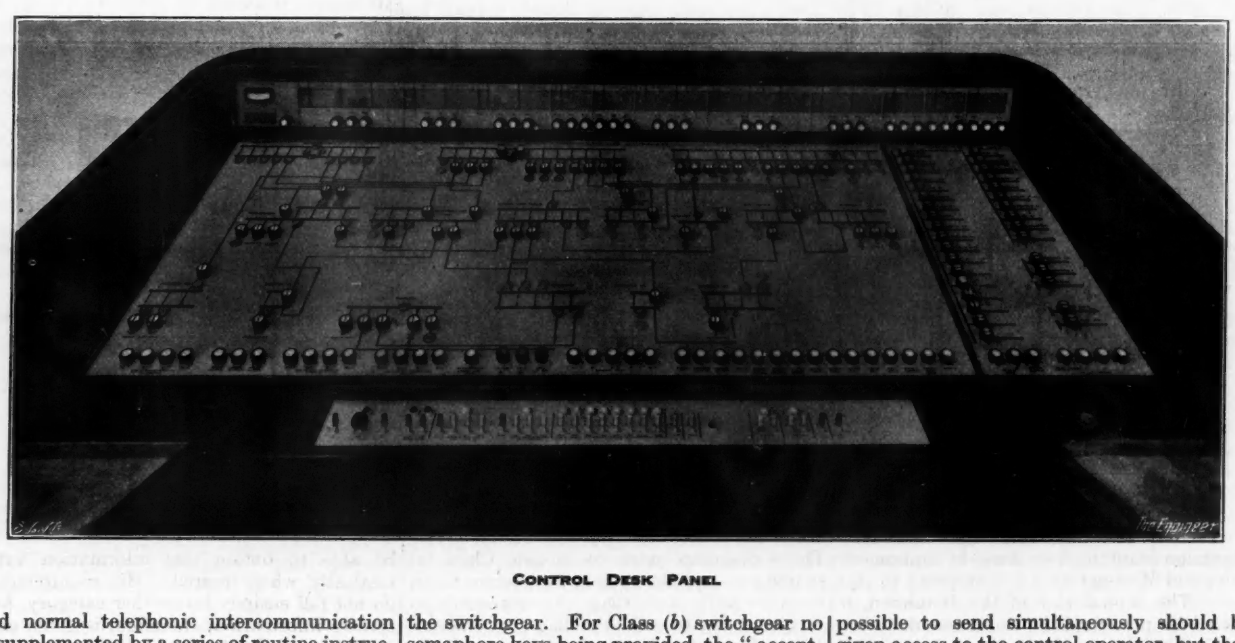
An inspection of the accompanying illustrations of the control room and control desk panel reveals the network diagrams and the metering panels. The telephone equipment is controlled by the row of keys at the front of the desk, but additionally at the back of the desk will be seen a vertical panel. This is the "Alarm Discrimination Panel," whereon a section is allocated to each station or sub-station on the supervisory control system. Its function is primarily to direct the control operator's attention to the appropriate part of the network diagrams whenever an automatic trip occurs. In this event the legend "Breaker Change" in the section appropriate to the particular sub-station flashes slowly and continues to flash until the change has been "accepted." "Acceptance" takes two forms :—For Class (*a*) switchgear it is necessary to rotate the corresponding semaphore key on the desk into agreement with the new condition of the switchgear. For Class (*b*) switchgear no semaphore keys being provided, the "acceptance" is effected by the depression of a "Re-set" key on the alarm discrimination panel below the group of sub-stations in which the affected sub-station lies. It will be noted that there are nine such groups with a spare position for a tenth.

Also associated with each group of sub-stations are two other keys designated "Check" and "Test" respectively. The "Check" key enables the control operator to verify the indicated condition of the switchgear at the sub-stations within the group itself, its operation causing a signal to be sent to these sub-stations, which thereupon return a complete indication of the condition of every element of switchgear concerned. The request signal having been sent, the "On Check" legend lights on the alarm discrimination panel in the section corresponding to each sub-station in the group and remains alight until a complete check has been received.

The "Test" key enables the control operator to put the sub-stations in the group into an "On Test" condition, during which he may carry out his normal controls, receiving the corresponding indications of change without actually affecting the switchgear. The signal which puts the sub-station "On Test" disconnects the controls and indications from the actual switchgear, and transfers them to a dummy set which takes the form of mechanically latched relays. The transfer causes a signal to be returned from the sub-station to the control operator, causing "On Test" legends to light in the appropriate sections of the alarm discrimination panel. When the control operator has, by the use of this facility, thoroughly routined his supervisory system, the same "Test" key enables him to restore conditions to normal, whereupon a check of the group of sub-stations re-establishes his network diagrams to the true conditions, the "On Test" legend being extinguished.

Other legends appearing on the alarm discrimination panel are "Low Volts" and "Sub-station Fuse." These give indications of the state of the supervisory equipment at the sub-station so that the control operator may know when a fuse has blown or when the battery volts are falling, so that the maintenance staff can take appropriate action.

The requirements of speed and safety demand that as many indications as it is possible to send simultaneously should be given access to the control operator, but that he should normally be unable to effect more than one control at a time. This is the case with the present system. From each group of sub-stations one signal only may be received at a time, each such signal giving complete indication of seven elements of switchgear. Thus, while the control operator may normally effect only one control at a time, he may receive at present up to sixty-three simultaneous indications and up to seventy indications when the tenth group of sub-stations is brought into service.



CONTROL DESK PANEL

BASLE AIRPORT.—A note in *Flight* records that the Swiss Federal Government is considering a project for the extension of the Basle airport. The commercial airport at Bâle-Birsfelden, for many years operated by a private company "Aviatik Beider Basel" (Aviation of Both Bâles), was found to be unsuitable owing to the expansion of port installations on the Rhine. A scheme to provide for a new modern airport at Allschiril-Burgfelden, Bâle, did not materialise because the airport would necessarily spread over the frontier into Alsace. The new project at present under consideration provides for the construction of an up-to-date airport at Hard at a cost of 4½ million Swiss francs. It is expected that it will be completed by 1944.

The Safety Factor of Winding Ropes in Deep Shafts

By DAVID R. BEAN, M.A. (Oxon)

IN a private communication, Mr. A. L. Egan, of Johannesburg, a centre in which the safety of winding ropes is a subject of perennial interest, proposed a dynamic factor of safety in place of the conventional static factor, which is well known to leave much to be desired. The proposal was to consider the maximum dynamic stress that could be caused in a rope without involving a shock load. This stress occurs in the rope at the sheave, when the oscillating skip is at the bottom of its oscillation, and the amplitude of oscillation is so great that at the top of the oscillation the skip just does not jump on the rope. In other words, the downward acceleration of the skip at the top of the oscillation is equal to g, and the tension at the lower end of the rope is momentarily zero. If the amplitude of oscillation were any greater, then at the top of an oscillation the rope would be theoretically in compression. In practice, of course, it would bend sideways, and when the skip descended it would impose a shock load on the rope, but such a load is not considered in the present theory.

From the maximum dynamic load thus determined for any particular set of conditions, the dynamic factor of safety is obtained by simple division into the breaking load of the rope. It has long been recognised that for a steel wire rope of 4000ft. suspended length a static factor of safety of 6 is good practice. The corresponding dynamic factor of safety for this particular rope and loading is then calculated, and it is proposed that all other long steel wire ropes may be loaded to the same dynamic factor of safety. We now investigate this proposal mathematically and work out a numerical example.

We neglect the length of rope between the head gear sheave and the winder drum, and we assume that force is transmitted along the rope at infinite speed, and not at the speed of sound.

CALCULATIONS

The general theory of the longitudinal vibration of an elastic bar fixed at one end and having a load at the free end is given in S. Timoshenko's "Vibration Problems in Engineering" (second edition, pages 308 to 319). We regard the winding rope as a bar clamped at the head gear sheave and the skip as the load on the end of the bar. The skip and all parts of the rope execute simple harmonic motions, all of a single frequency, and all in phase with each other, the centre of the motion of each particle being its position at static stretch. Only the fundamental frequency of vibration is considered.

Let l be hanging length of rope (feet).
m be mass of rope per unit length (lb. per foot).
M be mass of skip (lb.).
A be cross sectional area of rope (square feet).
E be Young's modulus of elasticity of rope (not of steel) (poundals per square foot).
g be gravitation constant (ft. sec.$^{-2}$).
Tg be breaking load of rope (poundals).
f be the dynamic factor of safety.
u be the longitudinal displacement of any cross section of the rope distant x from the sheave.

The fundamental equation of motion is

$$\frac{\partial^2 u}{\partial t^2}=a^2\frac{\partial^2 u}{\partial x^2}$$

the solution of which is

$$u=\sin\frac{p\,x}{a}\,.\,\mathrm{B}\sin p\,t \quad . \quad . \quad . \quad (1)$$

where

$$p=\frac{\beta\,a}{l},\ \beta\tan\beta=\frac{m\,l}{\mathrm{M}},\ a^2=\frac{\mathrm{E\,A}}{m},$$

$t=0$ initially at the point of static stretch, and B is a constant determining the amplitude of oscillation.

The special condition of our problem is that at the top of an oscillation the acceleration of the skip and of the lower end of the rope is g downwards, so that the tension at the lower end of the rope is zero at that instant. This condition determines the value of B in (1) above. Having found B, we find the rope tension at the sheave at the bottom of an oscillation, which is the maximum the tension that can come on the rope apart from shock loads.

The condition of the skip just not jumping on the rope at the top of an oscillation is

$$\left(\frac{\partial^2 u}{\partial t^2}\right)_{\substack{x=l\\ pt=\frac{3\pi}{2}}}=g,$$

or

$$\left(-\mathrm{B}\,p^2\,.\sin\frac{p\,x}{a}\,.\sin p\,t\right)_{\substack{x=l\\ pt=\frac{3\pi}{2}}}=g.$$

This reduces to

$$\mathrm{B}\sin\beta\,.\,p^2=g$$

whence

$$\mathrm{B}=\frac{g\,l^2}{\beta^2 a^2\sin\beta}$$

or

$$\mathrm{B}=\frac{m\,g\,l^2}{\beta^2\,\mathrm{E\,A}\sin\beta} \quad . \quad . \quad (2)$$

Hence, from (2) and (1),

$$u=\frac{m\,g\,l^2}{\beta^2\,\mathrm{E\,A}\sin\beta}\,.\sin\frac{p\,x}{a}\,.\sin p\,t \quad . \quad (3)$$

Hence, the maximum tension at the sheave is

$$\mathrm{E\,A}\left(\frac{\partial\,u}{\partial\,x}\right)_{\substack{x=0\\ \sin pt=1}}+\mathrm{M}\,g+m\,g\,l$$

$$=\frac{m\,g\,l}{\beta\sin\beta}+\mathrm{M}\,g+m\,g\,l$$

$$=\mathrm{M}\,g+m\,g\,l\,(1+1/\beta\sin\beta) \quad . \quad . \quad (4)$$

It is readily shown that the tension at any point in the rope is at all times positive when the oscillation is as described. From (4) the dynamic factor of safety is

$$f=\frac{\mathrm{T}}{\mathrm{M}+m\,l\,(1+1/\beta\sin\beta)} \quad . \quad . \quad (5)$$

NUMERICAL EXAMPLE

We consider as an example a representative winding rope used on the Witwatersrand. This has a fibre core, and six triangular strands, each consisting of ten outer wires, 0·125in. diameter, over twelve wires, 0·075in. diameter, over six wires, 0·066in. diameter, arranged in a triangle. The rope is of 1·5in. outside diameter, weighs 4·16 lb. per foot, and when made of 123–134 (short) ton steel has a breaking load of 114 short tons. The lay is Lang's and the loss of length in forming the wires into the strands is 3½ per cent., and on forming the strands into the rope is 5 per cent. Young's modulus of elasticity, based on the whole area of the circle enveloping the cross section of the rope—*i.e.*, a 1½in. diameter circle—is $1\cdot3\times10^7$ lb. weight per square inch of enveloping circle.

If a static factor of safety of 6 is allowed for a suspended length of 4000ft., the permissible skip load is 21,360 lb., and the dynamic factor of safety is 3·36. For this constant dynamic safety factor, the characteristics of various lengths of rope are :—

Length of rope, feet	0	2,000	4,000	6,000	8,000	9,960
Skip load, lb.	33,900	27,500	21,360	14,400	7,700	0
Half-amplitude of oscillation, feet	0	2·70	4·80	6·25	7·05	7·35
Period of oscillation, seconds	0	1·82	2·42	2·77	2·94	3·00
Static safety factor	6·72	6·37	6·0	5·80	5·69	5·51

For a constant skip load of 21,360 lb. we have :—

Length of rope, feet	0	2,000	4,000	6,000	8,000	10,000	28,000
Half-amplitude of oscillation, feet	0	2·17	4·80	8·08	11·9	15·9	81
Period of oscillation, seconds	0	1·63	2·42	3·15	3·81	4·41	9·95
Dynamic factor of safety ...	5·35	4·08	3·36	2·77	2·47	2·12	1·00
Static factor of safety	10·7	7·68	6·0	4·93	4·17	3·63	1·65

The first of these tables shows what has long been recognised, that the static factor of safety may be reduced for great winding depths. The comparatively small reduction shown, however, may be surprising until it is remembered that the present theory is based on the extreme condition of the skip just not jumping on the rope. In good practice, this extreme condition is not approached, and the greater the winding depth, the less likely it is to be approached owing to the greater effects of friction and the greatness of the ratio of the mass to be moved to the engine power available.

This investigation should therefore be regarded not as a prescription for an exact factor of safety, but rather as indicating an upper limit to the factor of safety required for great depths.

It is interesting to check the theory by calculating the total energy in the system at the top, middle, and bottom of an oscillation of extreme amplitude. The position of static stretch is taken as the position of zero potential energy. The energies are, in foot poundals $\times10^6$:—

	Top of oscillation.	Mid oscillation.	Bottom of oscillation.
P.E. of skip	3·27	0	−3·27
P.E. of rope	1·33	0	−1·33
K.E. of skip	0	1·64	0
K.E. of rope	0	0·44	0
S.E. of rope	0·02	2·50	9·20
Total energy of system ...	4·62	4·58	4·60

These figures are to slide-rule accuracy

only; hence the small discrepancies. The total kinetic energy at mid-oscillation—say, $2{\cdot}08 \times 10^6$ foot poundals—equals 117 H.P. seconds. The mean rate of transfer of energy from the kinetic to the potential form during a quarter oscillation is 194 H.P., which is a considerable fraction of the mean power of the winding engine which would be used with such a rope.

It will be realised that the maximum oscillation in this example is extremely violent, but that the dynamic factor of safety is still ample.

American Copper Mine and Reduction Works

No. III

(*Continued from page 100, July 31st*)

IN the battery of sixteen large ball mills a special feature is the delivery of the charges of grinding balls by lorries instead of the more usual method of utilising the overhead cranes, which are sometimes not available when wanted for this purpose. At this new plant a storage battery lorry with small cars operates on a platform running along the feed end of the mills, each car carrying a charge of balls. An overhead 150-ton travelling crane for handling the mills to and from the repair floor is supplemented by a 10-ton crane, which can handle light loads at higher speeds. Beneath the ball mill floor is a concrete vault, 130ft. by 25ft. and 10ft. high, having its floor level with the floor of the rougher flotation section. It houses the electrical control panels, the electrical cables from the transformer station being laid to the vault in tunnels.

The rougher flotation floor is 17ft. 6in. below the ball mill floor, and the cleaner flotation floor is 13ft. lower. The flotation plant consists of 240 roughing cells and 92 cleaning cells; the former are arranged in twenty rows, each consisting of eight primary and four secondary cells. They are all at the same level, except for a drop of 2ft. for the secondary cells. The flotation machines are of 66in. size for the rougher flotation and 56in. for the cleaner.

All flotation equipment is ranged in two independent rooms, each handling the product of eight ball mills. As each group is further divided into two sections, the plant can readily be operated at full, half, quarter, or three-quarter capacity, according to requirements. Both rougher and cleaner floors are served by overhead 5-ton travelling cranes. The concrete floors slope to drainage gutters, and all slop is caught and pumped back. All flotation machines, with their runways and operating platforms, are raised above the floor, with the piping for water, milk-of-lime, reagents, and compressed air beneath them. In this way the piping is out of the way, but easily accessible for repair or alterations. Each cell is driven by a vertical type gear motor, having its rotor mounted on the extended slow-speed shaft. Removal of four bolts enables the motor to be taken out, and spare units are kept ready, so that a replacement can be made in a few minutes without interrupting the flow of pulp.

Concentrate from the secondary rougher flotation cells and tailings from the primary cleaner cells are delivered to the regrind section of the plant, which is the lowest of the four floors and is about level with the main yard. Here there are three ball mills, 8½ft. by 12ft., each with a 54in. duplex spiral classifier in closed circuit. The feed enters the grinding circuit at the classifiers, and the product flows through a launder to a feed box, which is divided into six compartments to serve six 8in. sand pumps below the feed box. A railway spur entering the regrind section serves to handle supplies and especially the grinding balls, which are unloaded from cars by an electro-magnet.

These regrind mills handle pulp coming from any part of the two divisions of the concentrator, but their product is again divided, as three of the pumps serve one division and three serve the other division. The secondary cleaner flotation machines produce final concentrate and tailing, the latter being pumped back to the rougher section by 8in. sand pumps. Steel launders lined with rubber sheets cemented to the steel are used for the gravity flow of concentrate and tailing, the slopes or gradients adopted being determined by the kinds of pulp and the percentage of solid matter in the pulp.

Tailing is discharged from the flotation machines at four points into a launder leading to the centre of the floor, where the pulp drops through a pipe to the main tailing launder which leads to the de-watering plant. There the pulp enters a concrete distributing box serving four thickeners, each 300ft. in diameter. These are grouped around a concrete tank of a million gallons capacity, which gathers the clear water overflow from the thickeners. A pumping station with five centrifugal pumps of 5000 gallons capacity per minute returns this water to the head tanks, from which it again enters the concentrator circuit. These tanks also receive 5000 gallons per minute as make-up water from a storage reservoir 2 miles distant.

Underflow from the thickeners is carried to a spigot house by pipe laid in tunnels, each thickener having three 8in. pipes for this flow. The twelve pipes discharge into the head box of a launder leading to the tailing dams, a distance of about 3 miles, with an average gradient of 2 per cent. There are four dams, two on each side of a ridge along which the launder is laid. Distributing pipes carried on wooden trestles have 6in. plug valves at 54ft. intervals. Reclaimed water overflows through vertical shafts or "chimneys" into a concrete duct which runs through the dams to a pumping station having pumps with a capacity of 1000 gallons per minute to deliver the water to the million-gallon tank at the tailing dewatering plant.

The final concentrate, coming from the primary and secondary cleaner flotation cells, is led to two torque type thickeners of 100ft. diameter, whence the overflow is pumped back to the head tanks. The underflow or pulp is fed to elevators which deliver it to the filter plant; the dried cake goes to a conveyor leading to the concentrate beds at the smelter. In full operation the concentrator requires some 75 tons of burned lime daily for the milk-of-lime, or approximately 300,000 gallons of this milk. At present burned lime is purchased, but a quarry and lime burner will be developed later. The present lime hydrating plant has a tube mill and classifier for grinding and slaking, and has storage capacity for 750 tons of burned lime. Milk-of-lime is pumped to tanks of 300,000 gallons capacity, where agitators keep the lime in suspension. Reagents are stored in a building equipped with apparatus for mixing and dispensing.

At the smelter, concentrate from the filters is charged to reverberatory furnaces without roasting, and the matte is blown in converters to separate the iron and sulphur from the copper. Concentrate from the stock beds, which hold about 8000 tons each and are covered to prevent losses by dust, is excavated and fed by conveyors to bins over the two reverberatory furnaces. Matte is tapped into launders leading to ladles in the converter aisle. Slag, tapped near the flue ends of the furnaces, is run into ladle cars for transfer to the dump. Gases from the furnaces pass through two waste heat boilers. Three converters of the Peirce-Smith type treat the matte, and converter slag is poured back into the furnaces through the end wall. Copper from the converters is transferred to two tilting furnaces which serve a single anode casting wheel. The anodes are placed in the bosh tank by a hoist, and are removed to storage by a travelling crane. The converter aisle is at yard level, with the casting shed floor 4ft. above it and the reverberatory floor 15ft. above the aisle. The crushing plant at the smelter, served by railway cars and motor lorries, handles custom ore, siliceous ore, and lime rock for both flux and milk-of-lime for the flotation process. Beyond the jaw crusher is a mechanical screen. Converter flux is crushed to ⅝in. size and reverberatory flux for the reverberatory furnaces to ¼in. size, both by cone crushers.

Wet charging of the reverberatory furnaces was adopted, since roasting did not offer sufficient metallurgical advantage to offset the additional cost and operating troubles. The wet concentrate weighs about 125 lb. per cubic foot and has 9 per cent. moisture. A travelling tripper discharges the concentrate, plus 10 per cent. of the limestone flux, to 265-ton bins over the furnaces, from which steel pan conveyors feed it to a vibrating conveyor, 78ft. long. This conveyor, with a capacity of 50 tons per hour, feeds a series of charging spouts, 4ft. apart, along the side of the furnace roof.

Each reverberatory furnace is 110ft. long and 31ft. wide, outside measurement, and is designed to smelt 650 tons per day. They are built of silica brick, including the arch, which is 20in. thick and of 35ft. radius. The walls are 5ft. thick at the bottom and 1ft. at top, lined with magnesite, except in the charging zone. The bottom is a 2ft. layer of crushed silica on a bed of poured slag. The bath is nominally 3ft. deep. There are three matte tap plates, for alternative use, and a single slag tap. Two groups of four multiple-jet low-pressure gas burners fire through two rectangular ports. These burners are suspended from trollies, thus permitting removal from the firing position. Each group has an oil burner for auxiliary or emergency use. An 18-ton electric locomotive hauls ladle cars of 225 cubic feet capacity for slag removal, the tipping motors of the cars being controlled from the engine cab.

The three converters are 13ft. by 30ft., spaced 5ft. between centres, and are lined with 18in. magnesite brick. Ladles of 175 cubic feet capacity for matte and slag pouring are handled by travelling cranes having two 60-ton hooks. The enclosed cabs are provided with cooled air, which is filtered for removal of sulphur dioxide. Two 175-ton anode casting furnaces, 13ft. by 25ft., are lined with magnesite brick, which in the upper half is backed by insulating brick to reduce the heat loss. The 40ft. casting wheel carries twenty-six copper moulds for anodes weighing 700 lb. each.

The flue system is made short in order to reduce heat losses; flues 18ft. in diameter serve the converters, while those of the reverberatory furnaces are 15ft. in diameter. They are fitted with hopper bottoms and drag chain conveyors for the removal of dust. For final cleaning there is a multiple cyclone system composed of six units, each having forty-five cyclones, 16in. in diameter. Screw conveyors remove the dust to the collecting bins. The recovery is expected to be about 15 tons daily. Wet charging reduces the flue dust losses from the reverberatories, so that only about 1 ton daily is caught in the flue, but plans are made for a dust collecting system for these furnaces.

The stack or chimney for discharging the gases from the reverberatory furnaces and the converters is of reinforced concrete, 612ft. high, with an inside diameter of 38ft. 10in. at the bottom and 24ft. at the top. The thickness of wall is 3ft. at the bottom and 7in. at the top, which has a lead cap surmounted by a ceramic cap. A lining of acid-resisting brick extends from bottom to top, and the space between the chimney wall and the lining is packed with glass-wool insulation. As a protection against corrosive gases that may escape through the lining and insulation the entire interior surface of the concrete is given two coats of acid-resistant paint. Protection of the exterior from escaping sulphureous gases that may envelope the chimney is provided by similar painting for 150ft. down from the top.

Royal Ordnance Factories

No. II

(*Continued from page 98, July 31st*)

TIME AND MOTION STUDIES AND INCENTIVE BONUS SCHEMES

AN objection can be lodged against the introduction of any system (such as ordinary piece-work) which offers an incentive to over-rapid and perhaps careless work in an industry where safety is such a vital consideration. Though this argument has weight in regard to incentive bonus payments, if these are not most carefully regulated, it fails to take into account the increased efficiency of production, and possibly even the enhanced safety, that might be derived from the results of motion studies properly applied. In any case there is less scope for these methods in explosives factories than in filling factories; but where it can be done it is clearly desirable to have processes standardised and timed.

Incentive bonus schemes have already been introduced in three filling factories. The result at the factory where this was first tried was to increase output by from 25 to 30 per cent. The experience gained here so far does not suggest that the quality of production is deteriorating nor that the accident rate is growing. In fact, a large part of the increased output can be attributed to workers starting work more punctually and leaving off nearer to meal breaks. This has led to instructions being given to introduce incentive bonus systems for all types of filling work to which they are suitable; but, in view of the novelty of the experiment and the ban under which the system has hitherto lain, the policy is to proceed by gradual steps. It should be borne in mind that the scheme will not work without provoking discontent among operatives unless a steady flow of materials and components can be maintained.

ABSENCE FROM WORK

Absence from work on account of sickness, injury, and other reasons continues to be a serious problem at Royal Ordnance Factories. It is high for both men and women at all kinds of factories, filling, explosives, and engineering; but it is specially high in the case of women at the filling factories. In the last week of May only three among all the factories had an absentee figure for women lower than 10 per cent., and at four factories, all engaged in filling, the percentage was higher than 20 per cent.

Up till twelve months ago there was in the factories no organised labour management, as it is understood in the best private industry. There were a few officers whose duties were mainly concerned with the appointment and discharge of workers and with some welfare services. Their status and qualifications were low. It was not until August, 1941, that the Ministry decided to appoint a Director of Ordnance Factories (Labour), who from that time began to build up a staff of labour managers in the factories. These officers have recently been instructed to give priority to the problems of absence from work.

The labour management departments in the factories (and it must be remembered that in any case they are only advisory to the superintendent) cannot work properly unless they have the support of a clear policy from headquarters. A Labour Division has existed at the Ministry of Supply for some time, and is responsible for many aspects of labour, both in Ministry of Supply firms and in the Royal Ordnance Factories, but it has hitherto given inadequate attention to the problem of absence from work. Indeed, the material upon which a policy could be based has not existed. Records of absence have been collected and circulated to the various officers presumed to be interested, but they have not been compiled in a form capable of yielding useful information nor even on a comparable basis. It is not surprising that little use was made of these returns, although on rare occasions they have suggested an investigation at a particular factory. Within the last two months an attempt has been made to systematise them, and a weekly return has been introduced showing the main reasons for loss of work. But the information asked for has still not been clearly defined, and comparable figures for each factory have yet to be obtained. Moreover, there are a number of separate authorities concerned with this problem. Inquiries have been made, often in isolation from each other, not only by the labour management organisation of the Royal Ordnance Factories, but by the Chief Medical Officer, the Director of Planning, and the Director of Public Relations.

HOURS OF WORK

The attention of Departments has been repeatedly drawn to the ill effects of long hours of work, and in the reply to the Committee's Twenty-first Report of last session, the Government accepted the view that it should assume more responsibility for hours of work, and indicated that all possible steps would be taken to reduce hours to a maximum of 60 per week for men and 55 for women (Twenty-fifth Report, H.C. 124, session 1940–41). Nevertheless, a large proportion of the persons employed in Royal Ordnance Factories engaged in engineering are still working hours much in excess of these limits. In two-thirds of the establishments hours of work for men exceed 60 per week and those for women 55. In three factories men work as many as 70–71 hours, and in two factories women are employed for 66.

The undesirability of such long hours has been admitted by the officers of the Ministry of Supply concerned, but it is alleged that there is insufficient labour available to reduce hours by working three shifts, and that shorter hours would be opposed by those workers on time rates whose earnings would be affected. Neither of these arguments is acceptable. Both show failure to understand that beyond a certain point (which is estimated to be roughly 60 for men and 55 for women) increase in hours is accompanied, except in the short run, by a decrease and not an increase in output per head. Hours should therefore be diminished, whether or not three shifts can be worked. And provided that output is maintained, time rates should be adjusted by agreement with the trade unions so that earnings on the shorter hours are not reduced. It has also been stated that hours of work should be determined by the factory managements in the light of local conditions. It is true that a measure of discretion must be left to managements in this as in other matters, but the fixing of maximum hours of work is essentially a matter of policy and should be decided centrally. The Committee condemns the failure of the headquarters officers concerned to reduce hours of work, and recommends that immediate action should be taken to impose the limits accepted by the Government.

CONCLUSION

In the Seventh and Eighth Reports of the session the Committee emphasised the importance of matters of organisation, especially at this stage of the war, when the first phases of hasty improvisation need to be replaced by carefully balanced plans which ensure the best possible utilisation of the limited resources of the country. They specially emphasised the need for the clear planning of programmes based on an accurate appreciation of existing factors and adequate forethought as to probable future developments. It further emphasised that, in the execution of the programme, a clear allocation of the responsibility of the various agencies was necessary. All that has been brought to light by the present inquiry into the working of the Royal Ordnance Factories serves to reinforce these conclusions.

There are clear signs of failure to plan with sufficient attention to securing a proper balance between the various parts, *e.g.*, a balance as between filling capacity and capacity for the manufacture of components. Again, the redundancy of labour in factories affords evidence of failure to look ahead with sufficient forethought and to adapt actual arrangements to probable future developments. Yet again, the discrepancies in the estimates of redundancy which have been found to exist between the headquarters officials and those actually in charge of factories indicate another aspect of faulty organisation. The division of responsibility for Royal Ordnance Factories and the confused dispersal of responsibility for matters affecting the handling of labour indicate a failure to recognise the importance of a clear appreciation of the proper functions of the various parts of the organisation.

The Royal Ordnance Factories should be contained in a single organisation which comprises all the functions, and only those functions, necessary to their operation. They must be regarded as a self-contained industrial unit which happens to be under the control of the Ministry of Supply but has no more essential connection with the other Departments of the Ministry than the management of a private concern engaged on its contracts.

Neither at headquarters nor at the factory has the machinery been provided to integrate the responsibility for the various specialist functions and services. At headquarters, there are, under the present system, in addition to the Labour Division of the Secretariat and the administrative section of the Directorate of Ordnance Factories, several different authorities who are each concerned with their special facet of the general problem. These are the Chief Labour Management Officer, the Director of Hostels, the Controller of Canteens, the Director of Establishments, the Director of Planning, the Director of Public Relations, and the Chief Medical Officer. Some of these authorities are under the Secretariat, others are independent entities, and there would seem to be no common focus on the whole problem below the level of the Supply Council. In the factories, effective control by the superintendent has been hampered by the encroachment of these specialist authorities, and the regional administration of filling factories was found to encourage this tendency. The principle of functional control is not in dispute. In any organisation so large and complex as that of the Royal Ordnance Factories such a development is inevitable, but the pendulum has swung too far and it is now necessary to restore the balance by bringing the control of these special subjects into closer relationship with, and stricter subordination to, the supreme administrative officer—at headquarters the Director-General and in the factory the Superintendent.

Attention has already been drawn to the need for placing the control of all types of Royal Ordnance Factories under one Director-General. It is further recommended that all labour questions inherent in the management of the factories should also be placed under the control of this same Director-General, and those which are at present administered by separate authorities should be transferred to him. The higher organisation envisaged by the Committee should consist of a Director-General of Ordnance Factories, with four Deputy Directors-General responsible respectively for engineering factories, explosives factories, filling factories, and labour. The Deputy Director-General of Labour should not merely have full access to all relevant information, and in particular to the Department's programmes, but should be brought into consultation at every stage in all matters involving major questions of Royal Ordnance Factory policy. Only if this officer has these kinds of information and opportunity can the production plans be properly laid and translated into efficient labour programmes. This officer must control all sections dealing with appropriate labour questions, including canteens, hostels, medical services, and welfare generally. He must be responsible for the formulation of all labour demands for Royal Ordnance Factories and their presentation to the Labour Division of the Secretariat. The functions of the Secretariat would be to co-ordinate the demands

for Royal Ordnance Factories with the remainder of the Ministry's demands, and they should be in the same relationship with the Directorate of Ordnance Factories as with other industrial organisations with which the Ministry has contracts. Neither the Deputy Director-General of Labour nor the Labour Division of the Secretariat should concern themselves with those matters of labour supply, such as recruiting, which are the proper concern of the Ministry of Labour.

Protective Coatings for Steel

A STUDY of protective coatings for steel surfaces subjected to both water and atmospheric exposure has been made by Mr. Charles H. Ellaby, formerly a civil engineer in the Engineer Department of the United States Army, for the purpose of providing some effective and economical coating for the steel control gates on the thirty-three dams and locks on the Upper Mississippi River and the Illinois River. Each dam has from twelve to fifty gates, and the area of steel at each dam averages approximately 250,000 square feet. Normally, the upstream face is submerged, while the downstream face is exposed to the air. But occasionally the gates are raised above the water level, and this condition of alternate wetting and drying is severe on paint coatings. The following is the substance of a paper read by Mr. Ellaby at the Chicago Museum of Science and Industry.

In the construction of the earlier dams, painting was regarded as relatively unimportant, and current practice was followed in the use of a lead pigment in a linseed oil vehicle. Rapid failure of such coatings and serious corrosion after three years' service showed that the materials used were entirely unsatisfactory. Investigation proved definitely that one cause of the pitting and corrosion was the presence of mill scale between the metal and the paint, and I was convinced that complete removal of such scale was a prerequisite for the satisfactory painting of steel surfaces where moisture would be present on the paint film for any extended period of time.

This research pointed toward the synthetic resin vehicle paints, and narrowed down to the 100 per cent. phenol-formaldehyde resin in combination with China wood oil as the vehicle. Test panels, or 30in. steel discs, were coated with different paints, and exposed to a weekly cycle of alternate wetting and drying for seven months. (1) One coat of iron oxide-zinc chromate-phenolic vehicle primer and two aluminium pigmented phenolic vehicle finish coats; (2) one coat of red lead linseed oil vehicle primer and two aluminium pigmented phenolic vehicle finish coats; (3) a heavy thick bituminous enamel and an aluminium pigmented bituminous vehicle finish coat; (4) three coats of 33 lb. red lead linseed oil vehicle paint. Indications of superior durability of the 100 per cent. phenol-formaldehyde coatings were perfectly clear after some two months.

In initiating research, paint manufacturers were diffident about recommendations for this severe service, professing ignorance as to the performance of their materials in underwater service. In most cases they fell back on the easy practice of recommending the then current linseed oil vehicle paints. However, there were some unsatisfied members of the paint industry, among whom was Mr. William T. Deacon, of St. Louis, who was likewise investigating the synthetics. From his opinion at that early time the following is quoted:—"We obtain maximum moisture and alkali resistance by using a phenol resinoid vehicle (Bakelite phenolic resin). The imperviousness of the film deposited, excluding the vapour of water carrying the alkali or acid in solution, accounts for its unusual resistance."

Having developed that apparently no one knew exactly what a synthetic resin was, I concentrated on an attempt to determine results by applications of the theoretically best commercial materials. Since my concept from the beginning had been that the vehicle carrying, binding, and cementing the pigment particles was preponderantly important, I confined my investigation to a few well-known pigments in theoretically sound phenolic resin varnishes. Very soon it appeared that the only manner in which a paint coating could impart protection was by remaining integral and thus preventing the ingress of water for dilution and air for oxidation.

Very early it was shown also that a coating resistant to relatively severe physical stresses was necessary to withstand the conditions of drift wood churning and revolving at high velocity almost continuously against the steel, creating severe abrasion. This conception resulted in the gradual reduction of the tung oil content of the vehicle from 50 gallons to 40 and then 33 gallons, and finally to 25 gallons to 100 lb. of resin, which increased the hardness of the film and its durability. It developed also that the coatings which were most efficient in underwater service were at least equally satisfactory in atmospheric exposure to other coatings which were durable for such exposure but unsuitable under water.

Attention was then directed to pigmentation, and after considerable experimentation it was determined to my satisfaction that apparently only one pigment—zinc chromate—possessed ability for what I term the chemical inhibition of rust, as a property apart from the integrity of film, which, as previously stated, I consider to be almost wholly the true inhibitive factor of a coating. Having observed very questionable results from this so-called inhibitive pigment in the small proportions generally used, a series of laboratory tests was initiated, using proportions from zero to 100 per cent. of the total pigment content of a paint. This developed that a proportion of 60 to 65 per cent. was the optimum.

However, although there was some merit in the use of a 60 to 65 per cent. zinc chromate-phenolic vehicle paint, it appeared to me that very little effective chemical inhibition could be achieved by pigment particles completely immersed and bound in the highly impervious medium such as phenolic tung oil varnish. I therefore began investigation of separately applied films of phosphoric acid, which are truly chemical inhibitors by virtue of their reaction with iron to create a non-corrosive iron phosphate surface on a material prior to the application of paint. These investigations developed almost miraculous results in the prevention of blistering of paint films and resultant corrosion.

This inhibitive treatment or wash, since it is largely water, may be readily, quickly, and safely applied to sand-blasted steel surfaces, and paint applied immediately after drying. Thus I reasoned that we could provide three protection factors by these painting operations, namely, the primary defence of an integral coating, then the secondary protection of the iron phosphate surface, and finally the effect of the inhibitive pigment.

In connection with the study of resistance of coatings to abrasion, and the erosive or cavitation effect of high-velocity water passing over the surface, the idea was conceived to introduce sand into the film to provide an additional wear factor. To simulate high-velocity abrasion, a machine was constructed consisting of a cylinder through which extended a shaft for mounting specially shaped test panels. The cylinder, which could be sealed, was filled with water containing a volume of sand far in excess of any proportion which could be created by flowing streams. The shaft was revolved in the water at relatively high speed and periodic determinations were made of the wear results.

It was soon determined that the sand could not be mixed into the paint prior to application, but must be embedded in the fresh wet priming coat and covered with two finish coats to secure optimum results.

Having determined, in my opinion, the most effective inhibitive pigment and the most durable and waterproof vehicle, applied over the most perfect non-corrosive surface practically available, and with the application of the films effected in the most effective manner to resist the elements to which they were subjected, I felt fairly secure as to the results. However, I discovered a new problem in securing adhesion between multiple coats of these materials. From observations of numerous applications in service, it became apparent that there was no separation of films where the undercoat contained an aluminium pigment. In every instance, these aluminium-pigmented finish films, adopted because of their light weight, and pleasing appearance when blended with concrete structures, as well as their resistance to the destructive effects of the ultra-violet ray on the binding medium of the paint, separated readily in underwater service from all the priming coats, regardless of their pigmentation.

Since most of the priming coats were of a bright sharp colour, this peeling of the aluminium finish resulted in a very unsightly appearance of deterioration, although the priming coat was providing complete protection. It thus became apparent that a simple method to secure both the protection of multiple coating, as well as a uniform film colour, was to incorporate a leafing aluminium pigment into the priming coat. The results of this procedure, after two years of service, have been practically perfect. Regardless of the materials used for the service in question, it is desirable to maintain the same or a similar colour in all paint films on a given area. This will not result in improper application of the separate films, since the appearance of new wet paint is quite different from a dry film.

Summing up the results of these seven or eight years of extensive investigations and tests, it is my opinion that the most economical, durable, and satisfactory protection for steel surfaces that can be achieved by the materials available to-day for the service in question has been determined. The procedure consists of:—(1) Complete removal of all mill scale, either by acid pickling or sand-blasting; (2) inhibitive treatment of newly cleaned surfaces with a phosphoric acid-sodium dichromate solution; and (3) application of at least three coats of a synthetic phenol resinol-tung oil varnish vehicle paint, pigmented to suit the particular conditions existing.

In confirmation of these tests, it may be noted that the vehicle is all important, since test panels indicate that of the two best, one is of the cheapest pigment (largely iron oxide), and the other is the more expensive pigment (aluminium). These were used in the same 100 per cent. phenol-formaldehyde resin varnish vehicle, and both are equally good over the inhibited surfaces. Through this research, changes have been effected in specifications for the procurement of a coating system which is excellent after two years' service, as compared with the original paints that failed within two or three months.

MEN OF MAUDSLAYS.—The Hon. Secretary of Men of Maudslays, Mr. Walter T. Dunn, M.I. Mech. E., 56, Lanercost Road, Tulse Hill, London, S.W.2, informs us that the following have been elected to the society:—H. Cecil Booth, F.C.G.I. (London); Sir Francis Carnegie, C.B.E. (Woolwich); C. B. Collett, M.I. Mech. E. (London); James W. Dewar, M. Inst. N.A. (Great Missenden); Walter T. Dunn, M.I. Mech. E. (Hastings); J. W. Harper, M. Inst. Mar. E. (London); J. H. Harwood, M.B.E. (Edgware); Sir Alfred Herbert, K.B.E. (Coventry); Colonel C. F. Hitchins, D.S.O. (London); Horace J. Hoare, M.I. Mech. E. (Salisbury); E. G. Izod (Weybridge); Lieut.-Colonel Philip Johnson, C.B.E. (Hounslow); Cyril Maudslay, B.A. (Smethwick); Joseph Maudslay, M.I. Mech. E. (Pontrilas); Henry E. Metcalf, M.I. Mech. E. (Kenley); H. S. Ratcliffe, O.B.E. (London); Sir William Reavell, Past-President, I. Mech. E. (Ipswich); W. H. A. Robertson, M.I. Mech. E. (Bedford); W. H. S. Robertson, A.M.I. Mech. E. (Bedford); J. H. Sampson, Assoc. M. Inst. C.E. (Sheffield); J. T. Shapley (Sheffield); Lieut.-Colonel Castle-Smith (Bridport); Frank Winterborne (London). The invitation from Mr. E. G. Izod (member) for the members to visit his extensive works at Weybridge is announced, and will take place on August 21st. Members will leave Waterloo Station at 9.27 a.m., arriving Weybridge at 9.57 a.m., where conveyances will be in waiting to take them to the works, morning and afternoon. Luncheon and tea by invitation in the works canteen.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The Scrap Position

Easier conditions have developed in the scrap market, but consumers, and particularly the steel makers, are not altogether satisfied with conditions. Complaints are generally of the quality of the scrap which is sent to the steel works. This perhaps is not surprising in view of the many scrap campaigns which have been directed to obtain quantity rather than to secure quality. Much of the scrap material which has been collected from what are described as "hitherto untouched sources," has not been of the quality which the steel works have been accustomed to use, and although a decline in the standard may be expected in wartime, in some cases, according to report, the decline has exceeded what might have been reasonably anticipated. The steel makers, however, are meeting this problem in the spirit in which they have met many other problems during this war. The heavier classes of steel and cast iron meet with a good request, but the market seems to be rather overloaded with the lighter descriptions. Recently the free movement of scrap has been hindered by railway embargoes, whilst now that the Iron and Steel Control strictly allocates deliveries to the consuming works, buyers and sellers find that their freedom of action is somewhat circumscribed. There is only a poor demand for cast iron borings and bushy turnings, and stocks of these appear to be accumulating. There are good supplies of basic steel scrap, but the demand is not more than moderate. Supplies of several descriptions of the lighter qualities seem to be in excess of current consumption, and embargoes have been imposed at some of the consuming works. Large quantities of mild steel turnings are arising, and most steel works have received more of this description than they want, so that rather dull buying conditions have developed. There is also a somewhat poor demand for compressed basic bundles quoted at 66s. to 69s. 3d., and users have reduced their delivery acceptances.

The Pig Iron Market

There has been no development of importance in the pig iron market. The situation so far as the foundries are concerned is uncertain, and this factor will remain until foundries can see the effect of the concentration scheme which apparently is making satisfactory progress. The absence of information as to the course which will be adopted to meet the increases in cost arising from the higher fuel charges adds to the uncertainty felt in the trade. The demand for foundry iron, however, remains steady, although apparently a number of consumers will use stocks of pig iron until the situation becomes clearer. The heavy engineering producers of marine castings and heavy electrical engineers are large consumers, and are providing a big output for some of the higher quality pig irons. The hematite position remains tight, and only small parcels are being released, even in cases in which it is required for important Government work. The scarcity of this iron has led to a much greater use of refined iron and steel scrap. Consumers of high-phosphoric pig iron find that they can obtain fairly near delivery of their requirements, and liberal supplies appear to be available. On the other hand, there are indications that supplies of low-phosphoric pig as well as refined pig iron are becoming rather stringent. This, however, is only to be expected, in view of the extensive use of these pig irons for work for which in normal times hematite would be used. There has been no improvement in the position of the light castings foundries, and only those who have their own specialities are working at anything like a normal rate. The jobbing foundries also for some little time now have found that new business is becoming rather difficult to obtain and the textile engineering foundries, as a rule, are not operating at anything like capacity. Those foundries which are engaged upon Government work—and these include a big proportion of the heavy foundries—are finding no difficulty in obtaining all the pig iron they require, and, except in the case of hematite, the Control sees to it that their requirements are quickly and efficiently met. The demand for basic pig iron is on a heavy scale, but the production is sufficient to meet the steel works requirements, and the outlook in this department is satisfactory.

The Midlands and South Wales

The great activity at the Midland steel works, which has persisted for many months, shows no signs of diminishing. In fact, in one or two departments in which there has been some slackening in the volume of business coming forward, there has been an improvement, and consumers have shown more interest. One of the departments which has experienced a brisk revival of demand is the heavy structural steel section. The demand for heavy joists and sections which recently improved has developed some strength in comparison with the amount of business which has been transacted during the last few months. It is still, however, below normal, and many of the works could book additional orders. The activity in business in light steel sections continues, and there is a particularly good demand for angles and shipbuilding sections. There has been no relaxation in the demand for plates. Large tonnages of thick and medium plates are passing into consumption, and shipyards' requirements are fully maintained. The call for heavy sheets is also absorbing considerable tonnages, and there is a fair request for the lighter descriptions. On the whole, the sheet mills are busy, and there is an improving demand for black sheets for purposes for which galvanised were formerly required. A fair proportion of the work in hand at the sheet mills is for special quality sheets, principally for Government requirements. Business in steel bars is an active section of the market. The engineering industry is taking up large tonnages of the larger-diameter bars, whilst there is an urgent call for bright drawn steel bars, the demand for which has increased lately to meet the heavy demands of the armament makers and aircraft builders. These industries are also pressing for supplies of special and alloy steel, and their needs are taxing the resources of the producing works in spite of the considerable increase in productive capacity. All the South Wales steel works have enough orders on their books to keep them fully employed until the end of September, and almost all the work is for the fulfilment of Government contracts. There is increasing pressure to obtain supplies of steel billets, and the full home production is quickly taken up. The whole production of sheets and tinplate bars is absorbed, although the tinplate works are only moderately employed. The quietness in the tinplate department is due to the restrictions upon the manufacture and use of tinplate and there is little likelihood of any immediate change in the position. Business in substitutes for tinplate is somewhat slow to develop, although there is a moderate demand for black plates. Wartime Government restrictions naturally press hard upon the industry and there are reports that some works will have to close down.

Scotland and the North

Although the wartime demand has shown no signs of relaxing, quieter conditions developed for a time in the Scottish iron and steel trade, owing to holiday influences. It was expected that arrangements would be made by which the majority of the works would remain in operation during the usual holiday period, but when it came to the point, the idea of staggered holidays did not receive the support which the originators of the idea had counted upon. Advantage was taken of the holidays, however, to overhaul plant which, after such a long period of intensive work, was badly in need of attention. The works have now fully resumed, and heavy pressure is experienced in all departments. There is no decline in the demand for ship plates, and large tonnages are being absorbed by the shipbuilding industry. Tank makers and other large consumers are also taking considerable quantities. The demand for plates from the boilermakers has shown a tendency to decrease since the amount of work coming forward to this industry is tending to decline. There is an active business passing in special steel which is required in increasing quantities by the armaments and aircraft manufacturers. All the engineering works in Scotland are fully employed, and the former continue to take large supplies of steel bars. The sheet industry is also fairly well employed. Active conditions have ruled in the Lancashire market. The demand for semis, particularly billets, has increased, if anything, and the full production of the home works is passing into immediate consumption. Works producing billets and sheet bars have heavy order books and fresh orders are being continually pressed upon them. There has been a brisk call for bright-drawn steel bars, which are being taken up in increasing quantities by engineering firms employed upon Government work. Lately there has been some improvement in the demand for heavy joists and sections, whilst there has been no falling off in the call for the lighter sizes of structural steel. The steel works on the North-West Coast are heavily committed for the current period, and although fresh business is being pressed upon the works they have enough business in hand to keep them fully employed to the end of September.

The North-East Coast and Yorkshire

The steel works on the North-East Coast are operating under intense pressure, but have been successful in maintaining their rate of deliveries. There is a big production of steel, including a large output of special steel which is required by the armaments and munitions makers in considerable quantities. The pressure to secure big deliveries of semis is one of the features of the situation, and in this department the works have been operating at capacity for many weeks. The home production is supplemented by imports which are understood to have been increased of late. At any rate, consumers appear to be receiving all the semi-finished steel they require and the re-rollers are in a satisfactory position so far as their supplies of billets are concerned. The recent improvement in the demand for heavy joists and sections has been maintained, but it is still below normal. On several occasions during the past twelve months the demand for this class of material has sharply revived, only to die away again, and there are few producers who think that consumers' requirements will be maintained long at the present level. Large tonnages of plates are passing to the locomotive, wagon, tank, and boiler makers, and the works producing plates have good orders in hand. There is an active request for colliery steel in the shape of pit props, arches, &c., but the works are meeting the full demand. The Yorkshire steel industry is fully employed, and the heavy demand for basic steel has shown no signs of relaxing. The raw materials position is satisfactory, and big outputs are being maintained. Under the pressure of war conditions basic steel is frequently used for purposes for which acid carbon steel was formerly insisted upon. Notwithstanding this movement, however, the makers of acid carbon steel are fully employed, and have good order books. There is also a large production of alloy steel which passes immediately into consumption. Engineers employed upon war work are taking considerable quantities of tungsten grades of high-speed steel, although consumers are encouraged to use substitutes wherever possible. There is an active demand for steel castings and the establishments on this class of production have a large amount of work in hand.

Copper, Tin, Lead, and Spelter

The general situation in the non-ferrous metal trades in Great Britain shows little change from week to week. The official prices which have been fixed by the Control appear in the main to be satisfactory, whilst supplies of all metals under the supervision of the Control are reaching the firms engaged upon war work in adequate quantities. The Non-ferrous Metal Control has announced that the offer which was made in January, 1941, to purchase brass ingots at £35 f.o.r. makers' works has been withdrawn. These ingots were to a fixed specification, and were known as "N.C.B. brass ingots." Although full supplies of copper are available for the war industries, the Control is obliged carefully to scrutinise applications for licences, since there is no margin for supplies for non-essential work. . . . The tin position in Great Britain has been stringent since the Far Eastern sources of production were overrun by the Japanese, but the worst phase of the tightness has probably been overcome and the measures which have been taken by the United Nations to conserve supplies by restricting the use of the metal and finding substitutes have been successful. It is now believed that sufficient tin should be available to meet the needs of the United Nations for the duration of the war. No tin, however, can be spared for any but absolutely essential war purposes. . . . Although no lead is available for civilian purposes, firms engaged upon war work receive all the metal they require. The scheme for concentrating the industries making lead products is understood to have been successful in considerably reducing the consumption of the metal. It is probable, however, that there will be an increase in the production of lead pipes which will be required for camps in Great Britain. . . . In Great Britain and in the United States the spelter position remains tight. Little metal is available, except for national purposes, and in both countries drastic restrictions have been imposed upon the use of spelter. It does not appear, however, that any firms engaged upon war work have had to go short, and this is probably due to the careful supervision of distribution by the Controls in Great Britain and the United States.

Notes and Memoranda

Rail and Road

Travel Restriction in the United States.—The railway companies in the United States are now taking steps to check, as far as possible, all non-essential railway travel for the duration of the war. The advertising of travel facilities will cease, publicity being limited to information about the part being played by the railways in winning the war.

Announcing Station Names.—The L.P.T.B. has installed an "auto-announcer" at an underground station. The apparatus is put into operation by the arrival of a train and announces the name of the station just before the train stops. Then it calls out the destination of the train and afterwards repeats the name of the station. The various announcements are recorded on sound film.

Railway Construction in Mexico.—The Mexican Government has resumed, after a year's suspension, the construction of the Ferrocarril Sud-Este (South-Eastern Railway) from Coatzacoalcos through the states of Tabasco, Chiapas, and Campeche to the city of Campeche, where it connects with the Yucatan Railway system. It is reported that some at least of the sections will be used as a highway until rails are available.

"Carryalls."—This is the name given in America to large tyres for trucks or lorries built to transport heavy loads. Considerable research is being devoted by manufacturers to cutting down the rubber content, and one concern claims that in its latest model some 70 lb. of rubber will be saved. This reduction does not affect the load capacity of the tyres, but will cut the estimated working life from 30,000 to 20,000 hours, or, say, five years of service for contracting work and ten years in the Army.

Locomotives on Order.—U.S.A. returns for deliveries of locomotives to April 30th have been announced. The total number of railway locomotives was 132, as compared with 125 in March and 74 in April, 1941. The number for this year's first four months was 446 locomotives, including 166 steam, 6 electrics, 254 diesel-electrics, and 20 of other types, as compared with a January–April, 1941, total of 264. Unfilled orders at the end of April totalled 1425 locomotives, including 669 steam, 50 electrics, 670 diesel-electrics, and 36 of other types. The comparable total figure on April 30th, 1941, was 622.

Air and Water

English Canals.—The recently issued Order under which the Government assumes control of the principal canals and public carriers by canal under a scheme similar to that which is exercised over the railways, has disclosed the fact that under it the Minister of War Transport takes control of the undertakings or portions of undertakings in Great Britain wholly owned by, leased to, or operated by no fewer than twenty-nine concerns.

The Niagara Falls Power Company.—After an inquiry and investigations which have lasted more than twenty years, the U.S.A. Federal Power Commission has arrived at the "actual legitimate original cost" of the Niagara Falls Power Company's power plants at Niagara Falls, N.Y., at 24,680,680 dollars as at March 2nd, 1921, exclusive of 3,985,500 dollars reserved for further consideration. Under the terms of the finding, 15,537,943 dollars of the book cost of 44,453,868 dollars is to be removed from the fixed capital account and placed in the company's earned surplus account.

Clyde and Tay Canal.—The Joint Parliamentary Secretary to the Ministry of War Transport has stated in a written answer in the House of Commons that he does not think it practicable in present conditions to undertake a survey for the construction of a sea-level canal capable of taking large ships from the Firth of Clyde to the Firth of Tay, but that the project has been noted. He is prepared to consider proposals, submitted by the appropriate authorities, for the construction of road bridges close to the existing railway bridges over the Firths of Forth and Tay.

Miscellanea

A Record for Seasonal Water-borne Ore.—Owing to ice, the transport of ore on the Great Lakes, U.S.A., is seasonal. By using ice-breakers earlier than usual in the spring there is a prospect of creating a record this year. The previous record of 65,204,600 tons of ore moved on the Great Lakes during 1929 was easily beaten by the 80,116,360 tons in 1941, and the total this year is expected to exceed 90,000,000 tons. Of that amount 5,000,000 tons will be attributable to the unusually early opening.

The Late Major B. H. Butler.—We regret to learn of the death of Major Basil H. Butler, one of the governing directors of Kirkstall Forge, Ltd., which took place very suddenly at Leeds on July 29th.

Swiss Synthetic Rubber.—News has been received that synthetic rubber will shortly be produced in a factory near Zürich. The value of the new material is stated to have been demonstrated in tests with bicycle tyres and insulating materials.

New American Pipeline.—The construction of an oil pipeline from Texas to Illinois is being started immediately. When completed, the line will deliver 300,000 barrels of crude oil daily in Illinois for transport eastwards by rail, river barge, and pipeline.

Mercury of High Purity.—For power rectifiers, particularly in plants refining magnesium and aluminium, mercury of a high degree of purity is necessary, and a grade rated at 99·99995 per cent. purity is being made from U.S. commercial metal by the General Electric Company, at Schenectady, N.Y., in a special mercury purification plant in the Schenectady works laboratory.

Nickel from Cuba.—With an abundance of nickel in Canada, it is a little surprising to find the U.S. Government making a special effort to develop the low-grade nickel ores of Cuba. The chemical and metallurgical processes entailed are being undertaken by the Nicaro Nickel Company, a recently formed subsidiary of the Freeport Sulphur Company, which through another subsidiary also produces manganese in Cuba.

The Repair of Bomb-damaged Houses.—Only a qualified expert on the spot can decide what to do to a bomb-damaged house, after taking into account all the complex factors which affect the decision in a particular case. One of these factors, on which data have hitherto been lacking, is the strength of damaged walls. Wartime Building Bulletin No. 21, recently issued by the Building Research Station of the Department of Scientific and Industrial Research, to help the expert in making his decision, gives him the results of laboratory and field tests carried out by the Building Research Station on the strength of damaged walls. The Bulletin also contains some general suggestions on repair problems, including the treatment of dry rot and the decoration of damaged houses. It is published by H.M. Stationery Office, price 1s. net.

Fuel Economy in Ordnance Factories.—The Fuel Efficiency Committee of the Ministry of Fuel and Power recently discussed with the Government Departments concerned the question of fuel economy in Royal Ordnance Factories. The field covered was very wide and comprised every possible way of cutting out waste and of increasing efficiency in the generation and use of power and steam. It was stated during the meeting that the Royal Ordnance Factories have formed a small body of experts who are already going to individual factories and seeing that every possible means of fuel economy is practised. Already the savings effected are appreciable, and further substantial economies are expected. The suggestion was raised that owing to a shortage of qualified men, women might be trained in certain aspects of fuel economy. A further suggestion was that Works Production Committees should be approached with a view to their using their influence to secure fuel economy.

Industrial Gases in Cylinders.—The British Oxygen Company, Ltd., informs us that under the Gas Cylinders (Conveyance) Provisional Regulations, 1942, issued by the Home Office, an increased pressure of 10 per cent. is now permitted in the filling of cylinders containing oxygen, nitrogen, air, hydrogen, coal gas, or recognised mixtures of certain gases. The effect of this Order is that the normal pressure of cylinders, when filled with these gases, will be increased from 1800 lb. to 1980 lb. per square inch. This increase will enable cylinders to carry a larger quantity of gas and will thus improve the cylinder situation. All cylinders containing the above-named gases issued from the company's works on and after August 2nd, 1942, will be filled to the increased pressure. Where orders are received specifying the volume of gas required, the nearest approximate number of cylinders to give the required volume will be supplied. Where the order is for a specific number of cylinders, the company will assume that it is to deliver the number required, and each cylinder will contain a volume of gas increased by 10 per cent. above its previous capacity. In cylinders having a capacity of 60 cubic feet and upwards at the previous pressure of 1800 lb. per square inch, the increased volume of gas supplied will be charged for in accordance with existing prices. Cylinders having a nominal capacity of 40 cubic feet and less will also contain at the increased pressure a volume of gas increased by 10 per cent., but as the price is fixed at so much per cylinder, the company does not intend to charge for the additional gas supplied in these small cylinders.

Moving Idle Machinery to South America.—The war reverses many production processes and modifies others. Time was when raw materials were transported long distances to plants and factories. Now the machines and plant from consumer industries in the United States, which have ceased production because of the war, are being shipped to South America, so that the consumer goods may be manufactured there.

Combined Production and Resources Board.—The Combined Production and Resources Board was set up in Washington by the President of the United States and the Prime Minister on June 9th. As with other Combined Boards, some of the business can more conveniently be discharged in London, and a London C.P.R.B. has therefore been set up. Its members are Mr. Oliver Lyttelton and Mr. W. A. Harriman, acting as Mr. Donald Nelson's representative. Both Mr. Lyttelton and Mr. Harriman have appointed deputies, who are Sir Walter Layton and Mr. Philip Reed. There are joint British and American secretaries. The London C.P.R.B. will be concerned, among other things, with questions arising out of the supply of munitions from British production to American forces in this country. This is the third of the Combined Boards to have a London organisation. The other two are the Combined Munitions Assignment Board, which allocates munitions to the various forces and theatres after they have been produced, and the Combined Shipping Adjustment Board.

Personal and Business

Mr. E. C. Bredin, chief mechanical engineer, has been appointed general manager, Great Southern Railways, Eire.

The B. and A. Engineering Company, Ltd., has changed its London address to 50, Pall Mall, S.W.1 (telephone, Abbey 4686).

Lieut.-Colonel R. A. Bartram has been appointed Chairman of the Wear Shipbuilders' Association in succession to Major R. N. Thompson.

Mr. E. C. Little has joined the board of Bell's Asbestos and Engineering, Ltd. He has just entered upon his fifty-fifth year of continuous service with the company.

Mr. M. A. Crane, who recently retired from the post of senior locomotive superintendent, Gold Coast Government Railway, has joined the staff of Beyer, Peacock and Co., Ltd.

Sir Charles Craven has now recovered from his recent illness and has resumed his duties as chairman and managing director of Vickers-Armstrongs, Ltd., and English Steel Corporation, Ltd.

The Ministry of Aircraft Production announces that the Secretary of State for War, at the request of the Minister of Aircraft Production, has agreed to release Mr. E. M. Fraser, Director of Investigations and Statistics at the War Office, to take up the appointment of Director-General of Equipment Production at the Ministry.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Automobile Engineers

Wednesday, Aug. 19th.—Luton Centre: George Hotel, Luton. General meeting. 6.30 p.m.

Tuesday, Sept. 1st.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Supercharging the Compression-Ignition Engine," C. B. Dicksee. 6 p.m.

Institution of Electrical Engineers

Saturday, Sept. 5th.—London Students: Visit to works of the Fuller Electrical and Manufacturing Company, Ltd. 1.30 p.m.

Keighley Association of Engineers

To-day, Aug. 7th.—Arcade Chambers, North Street, Keighley. Annual general meeting. 8 p.m.

Men of Maudslays

Friday, Aug. 21st.—Visit to the works of Mr. E. G. Izod. Full particulars will be notified to members.